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THESIS

AN INTERNAL REVIEW AND OPERATIONAL TRIAL OF A HUMAN FACTORS ENGINEERING SELF-PACED COURSE IN ACCORDANCE WITH THE INSTRUCTIONAL SYSTEMS DEVELOPMENT PROCESS

by

Martha Marie Fleming

December 1983

Thesis Advisor : R. A. McGonigal

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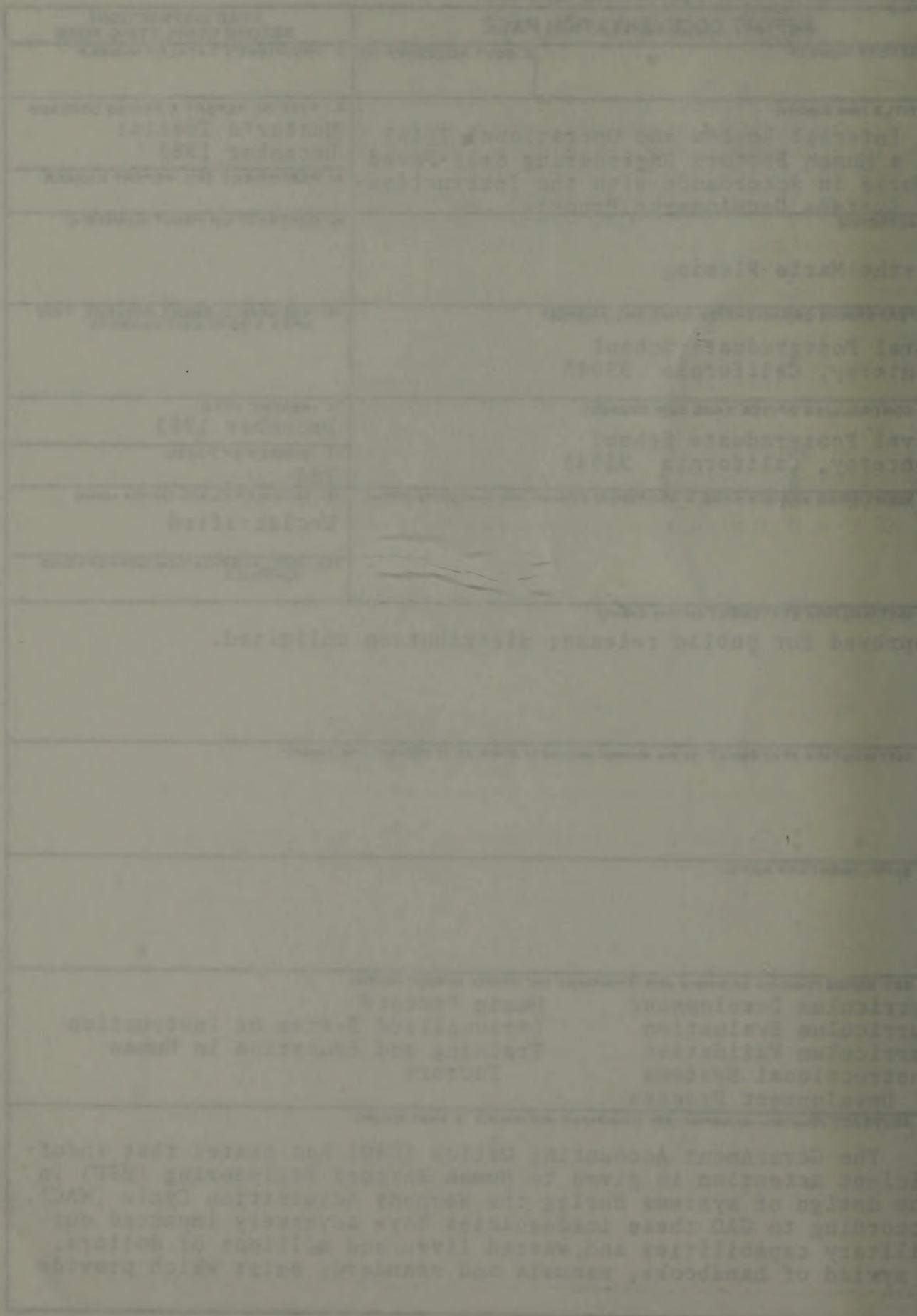
The Government Accounting Office (GAO) has stated that insufficient attention is given to Human Factors Engineering (HFE) in the design of systems during the Weapons Acquisition Cycle (WAC). According to GAO these inadequacies have adversely impacted our military capabilities and wasted lives and millions of dollars. A myriad of handbooks, manuals and standards exist which provide



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detailed guidelines, criteria, and test plans for conducting HF T & E which remain unused because their technological level is beyond the average user. The need for basic training in HFE has been clearly identified. A cost effective vehicle to bridge this gap in conceptual knowledge has been developed in the form of an HFE Self-Paced Course. As coordinated with the course's sponsor, an internal review and trial run were conducted, via this thesis, to assess its potential effectiveness. According to the results, this course has proven its capability to provide the stimuli necessary for the transfer of basic knowledge and skills in HF T & E. Additionally, the value of the job tasks identified in the course's terminal objectives were substantiated. The conclusions provided in this study are intended to encourage further course development through incorporation of the recommendations outlined. Ultimately, this would lead to its validation and implementation into the instructional system of the military. Implementation of such a basic course could be a major step toward increased integration of HF T & E during the Weapons Acquisition Cycle.

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An Internal Review and Operational Trial of a Human Factors Engineering Self-Paced Course in Accordance with The Instructional Systems Development Process

by

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Lieutenant, United States Navy
B.S., Sam Houston State University, 1971

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL

December 1983

ABSTRACT

The Government Accounting Office (GAO) has stated that insufficient attention is given to Human Factors Engineering (HFE) in the design of systems during the Weapons Acquisition Cycle (WAC). According to GAO these inadequacies have adversely impacted our military capabilities and wasted lives and millions of dollars. A myriad of handbooks, manuals and standards exist which provide detailed guidelines, criteria, and test plans for conducting HF T & E which remain unused because their technological level is beyond the average user. The need for basic training in HFE has been clearly identified. A cost effective vehicle to bridge this gap in conceptual knowledge has been developed in the form of an HFE Self-Paced Course. As coordinated with the course's sponsor, an internal review and trial run were conducted, via this thesis, to assess its potential effectiveness. According to the results, this course has proven its capability to provide the stimuli necessary for the transfer of basic knowledge and skills in HF T & E. Additionally, the value of the job tasks identified in the course's terminal objectives were substantiated. The conclusions provided in this study are intended to encourage further course development through incorporation of the recommendations outlined. Ultimately, this would lead to its validation and implementation into the instructional system of the military. Implementation of such a basic course could be a major step toward increased integration of HF T & E during the WAC.

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TABLE OF ABBREVIATIONS

ARPA	Advanced Research Project Agency network
ASVAB	Armed Service Vocational Battery
CCS	Command Course Supervisor
CNET	Chief of Naval Education and Training
CNTECHTRA	Chief of Naval Technical Training
DOD	Department of Defense
GAO	Government Accounting Office
HDBK	Handbook
HEDGE	Human Factors Engineering Data Guide for Evaluation
HFE	Human Factors Engineering
HFTEMAN	Human Factros Test and Evaluation Manual
LO	Learning Objective
MIL-STD	Military Standards (document)
MOAT	Mission Operability Assessment Technique
NAVEDTRA	Naval Education Training (document)
OPTEVFOR	Operational Test and Evaluation Force
OTD	Operational Test Director
PGS	Postgraduate School
PSI	Personalized System of Instruction
SIF	Student Information Form
STEP	Self-Teaching Exportable Package
T & E	Test and Evaluation
TLO	Terminal Learning Objective

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I. INTRODUCTION

There are many definitions available for the term "human factors". Simply stated, the major concern of all people involved with human factors is that of providing equipment and systems which people can use. Included in the various facets of human factors are design, test and evaluation.

Technology has advanced rapidly during the last decade. The development of the people who must make use of these "state-of-the-art" technological wonders has not kept abreast of the rapid growth in this field. For this reason, there has been increased attention to the human factors aspects of the new systems. Design engineers and evaluators must be cognizant of this fact, so that rather than designing equipment for fellow technical wizards' use, they must take into consideration the attributes and capabilities of the ultimate user. [Ref. 1: pp. 1-27] Referred to in U. S. Navy terms, the requirement is to make it "sailor-proof". Because the majority of sailors or non-prior service enlisted personnel as measured by the Armed Service Vocational Battery (ASVAB) (Table 1) fall into the lower mental categories [Ref. 2: p. 281], this requirement is of major concern when implementing new systems or equipment for their operation.

> Failure of deployed systems are often caused by human induced errors. There are indications that the percentage of failures due to human ineptitude or poor human

reliability[1] may be quite high. The increasingly complicated nature of modern military systems together with shortages of qualified military personnel suggests that human-induced errors both in operation and maintenance of systems will increase unless more attention is given to this problem in the design and development phases of the acquisition process. [Ref. 1: p. 27]

Table 1

Mental Category of Non-Prior Service Enlisted Accessions for 1978

Mental Category	Population Percentile	DOD	Army	Navy	Marine Corps	Air Force
I + II	65 - 100	34	26	38	29	45
III	31 - 64	61	63	60	68	55
IV	10 - 30	5	11	3	4	0

The Department of Defense [Ref. 1: p. 34] is aware of this problem and concurs that effective action must be taken to correct it.

Existing military instructions and directives [Ref. 4] state that human factors engineering must be integrated into the standard test and evaluation plans of all military systems. Command level documents [Ref. 5] include statements

---

[1]Human reliability as used here is defined as the probability that human error by either the operator or the maintainer will not cause a system failure or malfunction. The concept of system performance employed by the HFE Self-Paced Course is not concerned with human error that does not cause system failure. The evaluator concentrates on overall system performance. "The human is an integral part of a system and therefore his/her performance becomes a system component for evaluation. [Ref. 3: pp. 3-14]

which say that human factors aspects of equipments and systems will be assessed. All too frequently, however, test directors design the evaluation plan without human factors tests, or with human factors testing scheduled on a "not-to-interfere basis" or without considering the basic "...characteristics of personnel who will operate and maintain the system when it is eventually deployed, i.e., muscular strength and coordination, body dimensions, perceptions and judgment, sensory capacities, native skills and capacity to learn new skills, optimum workload, basic requirements for comfort, safety, and freedom from environmental stress." [Ref. 1: p. 29]

An additional problem arises when the evaluators become involved too late in the development and acquisition cycle--the "die have been cast"; the changes required are too expensive in terms of time and/or dollars. Thus test directors are forced into the world of trade-offs--instead of receiving the best, the user will get whatever the least costly compromise had to offer or whatever "hurt" the least. This often occurs because of the evaluator's inexperience with the design, test and evaluation processes and/or lack of guidance, training, and education in the field of human factors.[Ref 1: p. 10, 21, 31]

Various elements of the Department of Defense and civilian authors have attempted to develop documents which provide human factors engineering test and evaluation guidelines. Some

of these guidelines tell the planner when the evaluator should first become involved, others provide evaluation checklists and criteria against which to measure. A variety of documents even tell how to perform the tests. From discussions held with various members in the test and evaluation field, indications are that most of these existing references lie in sad disuse. They add that for all the expertise involved in their development, no one has to date, provided the one link that would put these documents into high demand: basic training and education in human factors. Valuable documents such as Human Factors Test and Evaluation Manual (HFTEMAN), Human Factors Engineering Data Guide for Evaluation (HEDGE), and Mission Operability Assessment Technique (MOAT), to name just a few, require a basic knowledge of human factors for their effective use. Consistent with human nature, it is easy to put off, ignore, or down play the importance of those things which are not easily understood.

Having recognized the need for basic training in human factors, the question then becomes one of implementation. The means of instruction must take into account cost effectiveness, and instruction standardized so that all intended users may benefit. During the 1970's and 1980's, the use of the Personalized System of Instruction (PSI) has gained in popularity and credibility [Ref 6: pp. 1-9] because of its economical feasibility [Ref 6: pp. 11-16] and attention to different individual learning styles [Ref. 6: pp. 73-75].

Critical aspects of the previously heretical concepts of PSI have been undergoing intensive study [Ref. 6: pp. 1-9; Ref. 7: pp. 587-592] with proven positive results. The major success or failure of PSI is greatly dependent upon its design considerations. The subject matter expert usually knows what content must be included, but often times lacks the familiarity and understanding necessary for PSI development to give all students an equal opportunity to master the content. Frequently, the problem lies in its method of presentation and delivery. [Ref. 8: pp. 40-43] Adherence to the basic requirements for a PSI design and development can produce an extremely effective course [Ref. 9: pp. 165-170].

Progressing with the advances of modern education and seeking cost effectiveness in delivering instruction, the HFE Self-Paced Course designers elected to develop a PSI for use with its small and specialized enrollment. The U. S. Navy has formally recognized procedures and agencies for PSI development, design, implementation and evaluation [Refs. 10, 11].

It is the purpose of this thesis to investigate a human factors engineering self-paced course which is anticipated to provide the missing link--education and training in basic human factors. Performance of this investigation will be accomplished in three phases:

1. Development of an evaluation plan for a self-paced course in human factors in accordance with CNET and CNTECHTRA directives.

2. Implementation of the evaluation plan in a realistic environment, and

3. Evaluation of the Human Factors Engineering Self-Paced Course.

A description of a preliminary draft of the Human Factors Engineering Self-Paced Course is provided in Chapter II. The evaluation plan used for the effectiveness assessment of the course is discussed in Chapter III. Methodology and results are addressed in Chapter IV. Chapter V presents this author's conclusions and recommendations. A final summary is given in Chapter VI.

II. THE HUMAN FACTORS ENGINEERING (HFE) SELF-PACED COURSE

The Human Factors Engineering Self-Paced Course is classified as a Self-Teaching Exportable Package (STEP) by NAVEDTRA 106A. As such, this course is intended to be self-supporting with minimal student contact required with the distributing command.

Once the course is implemented into the system, any military member may order the course materials from the sponsoring command or through standard military supply channels. Upon receipt of the course materials, the student may proceed with the lessons, working at home or during free time while "on the job". A recommended schedule is provided to each student as a guideline for meaningful and timely completion of the course materials. Thus the participant proceeds through the lessons on a self-paced basis while continuing to perform duties and tasks at the parent command.

This self-paced course has two formats: (1) a set of written manuals, and (2) a computer-based parogram planned to be available on the Advanced Research Project Agency (ARPA) network on a time-share basis. The total cost of either program is estimated to be considerably less in dollars (travel and per diem), man-hours required for training attendance, and man-hours lost from performing on-the-job tasks and duties while attending training than sending personnel to off-site human factors training facilities. This evaluation was

conducted using the written manuals because the computer version was not accessable at the time.[2]

Because the written materials are so extensive, they are not provided as part of this thesis. However, excerpts and summarizations taken from the course materials covering the course purpose, design, description, learning objectives and content are provided in the remainder of this section.

A. PURPOSE

This self-paced course was developed to provide HFE practioners with an awareness of its facts, principles and issues. The course designers have intended that upon completion of their course of study, each participant should "think about human factors whenever they are doing their job". Therefore, its purpose is to bridge the gap between Department of Defense (DOD) directives and instructions on HFE design, test and evaluation and the knowledge level of the novice HFE evaluator.

B. COURSE DESIGN AND STRUCTURE

The HFE Self-Paced Course is a STEP [Ref. 10: p.140], consisting of a student supplement, 40 lessons, and various

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[2]The computer version has been written but time and financial constraints made it impossible to evaluate. Portable computer terminals were required for distribution at test sites and these were not available. The program had also not been entered on to the ARPA network for systemwide access.

military standards (MIL-STDS), handbooks (HDBKs) and documents. The course is intended to provide the student with the same sort of instruction that would be found if she/he were the only student of an instructor. The written manuals consist of eight lesson books, each containing five lessons. The student supplement is to be used in concert with either the written or computer generated format.

The basic course has been divided into three modules/sections (major subject areas), the first contains 20 lessons, the second 15 lessons and the third two lessons. Practical application is required in lessons 38 and 39 while a full course review is provided in the last lesson. Each lesson consists of a series of small blocks of information. A question is asked at the end of each block to check comprehension and progress, providing immediate feedback to the student. Each question has several responses from which to choose and the student must select the answer believed to be best. The student is then either directed to a page from the lesson book or presented with a computer image which contains a comment on the selected answer stating whether it is correct or incorrect, and why. After providing remedial information following an incorrect selection, the student is directed to choose another answer. If the answer is again incorrect, the cycle continues until the student selects the correct answer. In the written format, the order of the material, questions and responses is scrambled so that it is

not possible to skim the pages of each lesson book and thereby skip the progress checks. Design of the computer version also eliminates "skimming". There are no "End of Module/ Section or Lesson Progress Tests".

Each lesson is developed in a story line. The central character is a junior officer (Lieutenant) who is unskilled and untrained in human factors. In the beginning, the lieutenant is characterized as having a negative attitude towards human factors. As the course continues, various events cause the officer to become a proponent of human factors. It is intended that the student learn from the numerous mistakes of the ficticious Lt. I. M. Eager and the guidance provided by his HFE mentor and boss, Capt. B. Smart.

In addition to the data presented throughout the lessons, a student supplement has been provided. As the student progresses through each lesson, he/she is asked to refer to the supplement. The supplement provides the student with graphs, photos and charts, some practical work (mathematics and drawings), and "nice-to-know" information.

The course has been designed with the intent that each should take no longer than one hour to complete, with an average completion time of 35 - 40 minutes and should be done on a daily basis. Therefore, maximum total completion time should not exceed 40 hours, or 40 working days if one lesson is finished per day. It is anticipated that the computerized version would, in all probability, reduce the completion time

for each lesson, as it eliminates the procedure of flipping through the lesson books searching for progress check responses and new material. The computer locates the response and displays it automatically for the student.

In addition to the aforementioned course materials various MIL-STDs, handbooks and documents are provided to the student and their usage is addressed throughout the course. Some are required for successful course completion[3], while

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[3]Documents required for successful course completion:

a. MIL-H-46885B. Human Engineering Requirements for Military Systems, Equipments and Facilities. January 1979.

b. MIL-STD-1472C. Human Engineering Design Criteria for Military Systems, Equipments and Facilities.

c. MIL-STD-1747B. Noise Limits for Army Materiel. March 1975.

d. MIL-HDBK-759. Human Factors Engineering Design for Army Materiel. March 1975

e. Army Regulation 602-1. Personnel-Materiel Systems: Human Factors Engineering Program. U. S. Army Headquarters, Washington, D. C., June 1976.

f. Technical Memorandum 29-76. Guide for Obtaining and Analyzing Human Performance Data in a Materiel Development Project. Berson, B. L. and Crooks, W. H., U. S. Army Human Engineering Laboratory, Aberdeen Proving Ground, Md., September 1976.

others are referred to as additonal resources[4]. While the basic package of reference documents provided with the course materials must be returned along with the lesson books to the issuing agency, they may be ordered through the standard military supply system. A brief summary of each of these resources is provided in Appendix A.

C. COURSE PRESENTATION

The course materials are presented in a manner which allows the student to complete the course of instruction without the aid of an on-site instructor. The student supplement is intended to be retained by the student and used

---

[4]Documents referred to but not required for course completion:

a. MIL-STD-721B. Definitions of Effectiveness Terms for Reliability, Maintainability, Human Factors, and Safety. August 1966.

b. FED-STD-595. Colors. 26 August 1964.

c. Holshouser, E. L., Guide to Human Factors Engineering General Purpose Test Planning (GPTP). Pacific Missile Test Center, Pt. Mugu, Ca.

d. Human Factors Test and Evaluation Manual (HFTEMAN), Vols. I, II, and III. Pacific Missile Test Center, Pt. Mugu, Ca.

e. Human Factors engineering Data Guide for Evaluation (HEDGE). U. S. Army Test and Evaluation Command. 20 December 1977.

f. Mission Operability Assessment Technique: A System Evaluation Methodology (MOAT). October 1979. TP-79-31. Pacific Missile Test Center, Pt. Mugu, Ca. Lt. W. R. Helm and M. L. Donnell, Ph.D.

as a "stand-alone" resource and reference document following course completion. The student may contact the issuing agency in the event additonal help is required.

D. COURSE LEARNING OBJECTIVES

In accordance with the recommendations of NAVEDTRA 106A, a list of performance requirements was collected by course designers after consultation with human factors engineering test and evaluation personnel. These were then restated into task requirements (Appendix B) and forwarded to the civilian contractor who was assisting in the course development. The course learning objectives (Appendix C) were then developed from this list of task requirements. No module or lesson learning ojbectives were developed.

E. COURSE CONTENT

As described in the introduction of the Student Supplement, the course is divided into three major content sections (modules): (1) human capabilities and limitations, (2) human integration with the system, and (3) "Human Factors in the Military".

Module I (Lessons 1-20) investigates the history and continued need for human factors engineering. Physiological capabilities and limitations of human beings and their incorporation into the proper design and controls and displays are addressed. Also included is a discussion of the human's

interactions with the surrounding environment and the effects it may have upon his/her performance.

Module II (Lessons 21-35) discusses: (1) the role of the human engineer in various aspects of analysis, i.e., systems, cost, task analysis and etc., (2) selection and training of personnel; and (3) experimental techniques and statistical concepts.

Module III (Lessons 36-37) focuses on human factors organizations, documents, and future applications. To provide students with a practical application of what has been presented in the course, lessons 38 and 39 present a "real world" problem for solution. Finally, in lesson 40, a more typical review of the entire course is conducted.

The outline of the Module and lesson topics is provided in Appendix C.

III. EVALUATION PLAN

> The validation process is a critical step in the development of lesson materials. The question to be asked is: "How can we be certain that the instruction works?" The only acceptable way to do this is to measure student performance. If the students learn the specified skill, task, or knowledge as a result of the instruction, then it is valid; if the students do not learn as specified in the learning objective, the instruction is not valid and must be revised. Validation can be compared to the testing process on a new piece of equipment. If particular components of the equipment malfunction repeatedly, then this indicates a problem that must be corrected if the equipment is to perform properly. By the same token, if the students fail to master a particular segment of instruction, a problem must be corrected. [Ref. 11]

To define the strategy used to assess the potential effectiveness of the instructional materials for the HFE course, an evaluation plan was developed (Appendix E), in accordance with the guidelines provided in NAVEDTRA 110A. The evaluation plan provided in this thesis combined several of the validation steps prescribed. These combinations were made because (1) no validation plan had been developed by the course sponsors, (2) no previous evaluation of the course materials had been conducted, and (3) the course was in an advanced state of development. While the computer version has been written, it is not available on a commonly accessible system. The evaluation was, therefore, developed using the set of written manuals.

A. HOW TO CONDUCT VALIDATION

Validation is accomplished by completing the following steps [Ref. 11]:

1. Interval Review. As the rough draft materials are evaluated, the following questions should be asked:

a. Is the content accurate?

b. Is the material presented in a logical fashion?

c. Does the lead-in information motivate the student to pursue the material?

d. Do the teaching-learning activities encourage productive learning?

e. Is the material written in a manner to allow maximum student participation?

f. Is there an opportunity for review and practice?

g. How effectively does the material teach behaviors specified in the learning objectives?

h. Does the test measure the behavior as specified in the learning objectives?

The internal review does not determine validity of the course material. It does, however, identify problem areas and suggest alternatives.

2. Individual Trials. Informal, individual trials on rough draft materials for each lesson will take place to identify gross deficiencies in the lesson materials "before" expensive final draft materials are produced. In other

words, these trials should help identify where more practice is needed, instruction is adequate, and whether instructor guides or student study booklets are complete. Since this is probably the first time students will actually take the test items developed for a lesson, the informal trial may also identify problem test items.

The individual trials should be conducted as follows:

a. Administer Pretests. Pretests are given to students to determine how much they know before being exposed to the instruction. The scores made on the pretest are then compared with scores made on post tests to ascertain the effect instructional materials had on student performance.

Tests developed for validation purposes are composed of the content items that address both enabling and terminal objectives. For validation purposes, however, it may be helpful to add test items to both pre and post tests which would be diagnostic in nature and therefore help to locate problem spots in the instructional materials.

b. Administer Instructional Materials. Observe the students' performances as they complete the lesson and record their completion time, the questions asked, and any difficulties observed.

c. Administer Post Test Items. This will measure mastery of the content by the students. The results will be used to identify strengths and weaknesses in the course and to provide a basis for making revisions.

d. Administer Student Feedback Sheets. This is the student's opportunity to suggest how to make instructional materials more effective. As such, the feedback sheet should be structured so that students' responses are channeled, yet flexible so that open ended responses are allowed.

e. Revise the Instructional Materials. Evaluate all data: test scores and instructor and student comments. Then make the revisions required. When all major deficiencies have been corrected and revalidated, the individual trials are concluded.

3. Group Trials. A minimum of six students should be used for each group trial. As with individual trials, it is very important to select students that are representative of the target population and that have the proper prerequisites for the experimental group. The steps for conducting group trials are the same as were followed during the individual trials with one major exception: this time, there is only one observer to six or more students. As students proceed through the instruction, they are not interrupted; they continue through it as would a normal class. Only upon completion of the lesson materials may students be asked such questions as why they missed certain items, did the instructional materials maintain their interest, were there enough practice items.

4. Operational Validation. Validation of a new or revised course will be conducted in the operational environment using the normal student population. The reasons for conducting the operational validation are:

a. Instructional materials must be evaluated as an integral part of a total system. Until now, individual and group trials validated portions of instructional material in an isolated environment.

b. Analysis of data from this larger sample will provide a solid basis for final revision and refinement of the course. Data gathered at this point will provide feedback concerning the adequacy of the learning analysis, learning objectives, criterion tests, and instructional materials. If students fail to meet the standards of the terminal objectives, reassessment of each of these procedures and products of the course design and development processes shall be scrutinized.

c. An operational trial provides an opportunity to work out administrative, equipment, facility, or any other implementation problems which may cause trouble later.

The steps for completing operational validation are:

(1) Review of Material by Functional Command. The functional command will review a cross-section of all instructional materials for content, technical accuracy, and format. These will include instructor guides, student study guides, remediation guides, media, student study booklets and

laboratory guides. Discrepancies noted by the functional command will be discussed with the curriculum designer.

(2) Administer Pretests, Instructional Materials, and Post Tests. As with both individual and group trials, it is absolutely necessary to have students with the appropriate entry level; without this, validation results are contaminated.

(3) Administer Student and Instructor Feedback Sheets.

(4) Analyze Results and Display/Present Data to Approval Authority. After administering all the tests, instruction, and feedback sheets, the results must be analyzed and displayed for submission to the approval authority. Prior to operational validation, a validation standard must be set. At this time, the validation test results are compared with the validation standard. If the standard is not reached, the curriculum designer should look carefully at the instructional materials, equipments, and management documents to locate the problems and decide on corrective action to be taken.

B. EVALUATION PLAN

The format used for the Evaluation Plan was modeled after that used by the original test site in evaluating equipment and systems [Ref. 5] because of familiarity with selected test site supervisors. Following its design and development,

other military branch sites requested to be included in the evaluation. A summary of the evaluation plan follows:

1. Purpose. The purpose of the evaluation was to provide an assessment of the potential effectiveness of the HFE Self-Paced Course and its potential value for use in the military test and evaluation community. The evaluation was planned in cooperation with the HFE Laboratory at Pacific Missile Test Center, Pt. Mugu, California.

2. Background. The HFE Self-Paced Course was developed to satisfy a need for increased awareness and more indepth understanding of human factors. The Government Accounting Office (GAO) highlights this need and identified a deficiency in the performance of various weapon systems

> ...because the DOD does not pay enough attention to logistic support, human factors and quality assurance during the design phase of the acquisition process. These problems deter the systems' effectiveness to defend our country in case of war. GAO, therefore, makes recommendations to improve the management and planning of ownership considerations that have an impact on the effectiveness of a weapon system. [Ref. 1: pp. 1-27]

The Human Factors Test and Evaluation Manual (HFTEMAN) Vols. I, II and III was distributed to various government agencies in October of 1976 by Pacific Missile Test Center. This document was developed to provide standardization in

procedures, testing and criteria in evaluating human factors. A basic knowledge of human factors terminology, principles and concepts was necessary for its most effective use. This was generally lacking and therefore HFTEMAN was not utilized as it was intended.

The HFE Self-Paced Course was developed to provide this basic knowledge. It has not been evaluated or used on a trial basis in any portion of the military prior to this study.

This researcher was tasked to (1) develop an evaluation plan in accordance with NAVEDTRAs 110A and 106A, (2) implement it, conducting the test in a realistic environment, and (3) analyze the data and provide results, recommendations, and conclusions. Additional taskings and responsibilities are described in Appendix E.

3. Prevalidation. This researcher conducted the internal review with the assistance of content and curriculum development subject matter experts.

4. Informal/Group Trials/Operational Trial.

a. Personnel Selection. Subjects participating in this evaluation were drawn from four military commands (two Navy and two Air Force) whose primary mission was operational test and evaluation of equipment and systems prior to their acquisition by DOD for service use. Personnel were to participate on a volunteer basis. Students selected from the

volunteers were to be representative of the target population which would be ultimately using the instructional materials. The following personnel prerequisites were established:

(1) Subjects were selected from various warfare communities, i.e., air, surface, subsurface and special warfare.

(2) No constraints regarding rate, rank, speciality code, grade, educational level or prior experience were imposed.

(3) Each subject was required to be actively involved in planning and performing test and evaluation.

b. Testing Constraints.

(1) Learning Center Instructor. No on-site instructors were available at any of the test sites, nor were they required. This researcher was designated as the students' contact point, temporarily fulfilling the future role of the sponsoring agency. A Command Course Supervisor (CCS) was identified at each location to assist this researcher in distributing and collecting course materials, tests, feedback sheets (questionnaires), and recording student questions or comments and demographic data.

(2) Personnel Selection. While HFE designers and evaluators are equally important, the availability of inexperienced equipment designers needing instruction was extremely limited as compared to those in equipment evaluation. The very dynamic and mobile nature of the course designers'

military target population identified the intended users of the course--U. S. military operational test directors involved in whole or in part in human factors evaluation. The original test plan called for the use of volunteers only, however, due to limited personnel availability, final analysis showed that some participants had been assigned.

(3) Course Materials. Original plans allowed 60 days for student completion of all 40 lessons of the HFE Self-Paced Course. As a result of delayed procurement of course materials, the actual evaluation was limited to 30 days and the first 20 lessons of the course.

(4) Course Completion. The personnel participating in this evaluation were also performing their normal jobs as test directors. Potential conflict was anticipated with their normal responsiblities which could require their absence from the command for a prolonged period of time and cause interruption in course progress or even termination.

(5) Learning Center. No area was available at any location which could be specifically designated for student use. Students studied in offices, libraries and at home. This was congruent with the course design and the intent of the study.

(6) Testing. No tests had been developed by the sponsor. The tests used in this evaluation were developed by

the author and had received only limited pretesting prior to the evaluation because of time constraints and therefore had not been validated.

(7) Training. No training beyond that offered by the HFE Self-Paced Course was conducted during the operational trial run of this study.

5. Judgment Criteria. Both the pretest and post test were designed in accordance with the objectives developed by this researcher (Table 2).

a. Pretest. The pretest was used to measure prior knowledge of the course content possessed by entering students. The pretest was composed of four different types of questions, each being assigned a specific point value for scoring:

multiple choice	1 point per answer choice
matching	1 point each response
fill in the blank	2 points each
short answer	3 and 5 points each

The scores of the Course Group were compared to those of the Control Group to ascertain entry level equivalency.

b. Post Test. The post test was administered after completion of 20 lessons of instruction to assess whether: (1) the students had mastered the objectives of the first module, and/or (2) the students taking the course knew more about human factors than students not taking the course. The

Table 2

Learning Objectives Developed (By the Researcher)
For Design of Pre and Post Tests

1. Given a list of human factors terms, write a definition for each in your own words.

2. Given a list of specific HFE probems and/or areas of concerns, identify which human factors references should be consulted to provide solutions and guidelines.

3. Given at least one control/display example, use the appropriate human factors reference to determine which features need to be redesigned.

4. Given a list of potential sources of technical information on human factors, identify the general purpose of each.

5. Explain in your own words the importance of evaluating the human factors aspects of systems and equipments.

6. Identify the human factors principles which must be applied during the evaluation of a workspace and control/display panel.

7. Given the four phases of the Weapons Acquisition Cycle, describe the HFE specialist role, the major HFE concerns and objectives of testing for each phase.

8. Given the mission statement and the three functions which must be performed for a particular system, determine the human performance requirements.

9. Given a list of 10 factors and forces which affect human performance; identify what aspect of human performance each affects.

10. Given a list of 10 factors and forces which affect human performance, identify what unit of measure must be used to assess the amount of protection required to diminish their adverse effects upon the human operator.

11. Explain in your own words, the importance of performing a task analysis.

12. Given a choice of 3 possible task analyses, correctly identify which satisfies the definition of "task analysis".

post test was composed of the same type of questions and the associated point values as the pretest; however, the proportionment of the four different types of questions was different so as to reduce "chance" selection of correct answers. The post test was designed to test the same learning objectives as the pretest. The post test scores of the Course Group were compared to those of the Control Group to determine whether or not learning had occurred as indicated by the Course Group's scoring significantly higher than the Control Group.

c. Test Items. Each test item was "referenced" to a specific terminal objective. Since each objective was a statement of a "criterion" for student performance, these tests for objectives were identified as "criterion-referenced" tests. The test items were developed in accordance with the guidelines provided in NAVEDTRA 110A. The questions and answers were extracted from the Human Factors Engineering Self-Paced Course, lesson 20 which contained review material covering lessons 1-10. Student responses which expressed the same answers as the course materials were given credit. Partial credit was awarded where possible. Test key answers were compared to the answers provided by selected HFE experts to ensure the HFE course answers were, in fact, correct.

Additonally, to help identify weaknesses, test items were added to both pre and post tests which were

diagnostic in nature and therefore would help locate problem areas in the instructional materials. Results were recorded for each test item.

d. Hypothesis for Comparison. If there was no statistically significant difference between the post test scores of the group completing the first module and the scores of the Control Group which did not take the course, it would indicate that the course materials were not effective and would be of no value for use in the military.

Further analysis would then be conducted on both the pretest and post test questions.

e. Statistical Analysis. The statistical analysis was performed on the pre and post tests and was intended to establish (1) the entry level equivalency of both the Course Group and the Control Group based on the pretest scores and (2) to establish a difference in the post test scores between the two groups. The results of the post test scores would therefore provide an overall statement of the potential effectiveness of the HFE Self-Paced Course.

f. Raw data for the pre-post test analysis for the operational tryout was provided to this author in conjunction with students' tests and is presented in summary form (Appendix G).

6. Standards

Criterion to establish equivalency between both the Course Group and the Control Group on the pretest scores had been set by this author. There must be no statistically significant difference at the .025 level (two-tail t test) to determine that the groups are equivalent in their pre-entry level.

Criterion to establish that learning has taken place with the Course Group had been set by this author. There must be a statistically significant difference between the Course Group and the Control Group post test scores, at the .025 confidence level (two-tail t test) to determine that the groups are not equivalent in their level of learning. To validate that the course materials were able to successfully provide the stimuli for knowledge and skills transfer to the students taking the course, their post test scores must be significantly greater than the Control Group.

Criterion guidelines were established by CNTECHTRA for acceptability of course objectives, design, presentation, availability, maintainability and supportability in NAVEDTRAs 110A and 106A and are summarized by this researcher in Table 3 and described in greater depth in Appendix E.

In the event the standards are not met following the operational tryout, instructional materials would be analyzed as indicated above.

Table 3

Evaluation Areas, Objectives, Criteria and Data Sources

AREA	OBJECTIVES	CRITERIA	DATA SOURCES
Course Objectives	Standardized in accordance with NAVEDTRAs 106A & 110A	Equivalent to Job Task Analysis. Must satisfy 6 characteristics: See Appendix E	Human factors analyst Job Task Analysis or Job Task Inventory Questionnaires
Course Design	Must aid student accomplishment of objectives.		
-Sequence & Structure		Course topic format and learning objective sequence must be equivalent.	Table of contents/lesson topics CCSs' Logs Learning Objectives (LOs)
		Both must also follow a logical order of progression.	Task breakdown derived from LOs Questionnaires CCSs' logs
-Figures & Tables		Must be self explanatory and meaningful.	Questionnaires CCSs' logs
-Symbology & Legends		Meanings must be implicit and/or standardized.	Questionnaires CCSs' logs
-Layout & Format	Must provide smooth flow and continuity of information to allow mastery of learning objectives	The order of the course topics must not cause confusion.	Questionnaires CCSs' logs
		Information frames must provide sufficient information to answer the questions at the end of each frame.	HFE Lesson Books Questionnaires CCSs' logs
		Must build motivation and encourage course completion.	Questionnaires CCSs' logs

Table 3 - Continued

AREA	OBJECTIVES	CRITERIA	DATA SOURCES
Course Content	Must support the tasks, skills, and knowledge identified by the LOs.	Mean of the Course and Control Groups' pretest scores must be equivalent.	Diagnostic Pretests Questionnaires CCSs' logs
		Mean of the course Group's post test scores must be greater than the mean of the Control Group's scores by at least 1 standard deviation.	Diagnostic Post Tests Questionnaires CCSs' logs
Course Presentation	Course completion must be accomplished without the aid of an on-site instructor.	Clarity of instructions and verbal context must be explicit.	Questionnaires CCSs' logs
		Sufficient level of detail and feedback to allow mastery of LOs.	Questionnaires CCSs' logs Course "Student self-Check Tests"
Course Availability	Course materials (including references) must be maintained in sufficient quantity to meet the needs of those it will serve.	All course materials and references must be available upon demand in its completed form.	Information provided by supporting agencies.
Course Maintainability	Course materials must be maintained for completeness and accuracy.	Course materials must be up to date with the most recent versions of the documents it references and upon which it was based.	Information provided by supporting agencies Questionnaires
		Course material must be consistent with the latest human factors policy and developments.	

Table 3 - Continued

AREA	OBJECTIVES	CRITERIA	DATA SOURCES
Course Supportability	Course must be supported by the issuing agency.	Sufficient personnel must be assigned to monitor the participants and provide adequate feedback on performance to allow mastery of the LOs.	Information provided by supporting agencies.
		Life Cycle Cost estimates must be available.	

7. Remediation

Students involved in the operational tryout receive remediation from the responses to the Progress Checks following each block of instruction within the lesson topics.

8. Instructor Training

The HFE Self-Paced Course was intended for use by individuals without the aid of an on-site instructor. The intent of the agency sponsoring the course is to provide a point of contact for students to answer any questions on content, procedures, etc., once the course is approved. There was, however, no instructor guide available during this study. If none is to be developed, the intended point of contact must then be a subject matter expert. The student and the expert would then talk through any problems using the set of student course materials.

9. Student and Instructor Feedback Sheets (Questionnaires)

The following student, Command Course Supervisor and Curriculum Development Expert feedback questionnaires were completed and returned to this author for review and analysis.

a. Annex (A) of Appendix E was completed by each participant in the evaluation during orientation.

b. Annex (C) of Appendix E was completed by each participant prior to the students beginning the course.

c. Annex (D) of Appendix E was completed by each participant after the Course Group had completed the first 20 lessons.

d. Annex (B) of Appendix E was maintained by each Command Course Supervisor (CCS) throughout the evaluation period.

e. Annex (G) of Appendix E was completed by experts in the field of curriculum development.

f. Annex (F) of Appendix E was completed by each Course Group participant upon completion of the post test.

g. Annex (E) of Appendix E was completed by each CCS upon completion of the evaluation period.

10. Display Format

Test analysis results are displayed as Appendixes F and G and discussed in Chapter IV of this thesis.

Analysis of the questionnaires are displayed in Appendix H and discussed in Chapter IV of this thesis.

IV. METHODOLOGY AND RESULTS

For this study 52 participants were chosen from four test sites, each of whom met the prerequisites for course entry as described below. These 52 participants were divided into two groups; one which would complete the course (Course Group) and the other (Control Group) which would not go through the course, but would be administered the pre and post tests. Since the pre and post tests were to be structured differently, the post test scores could not be compared to the pretest scores to measure the effectiveness of the course in providing the stimuli for transferring knowledge and skills in human factors. It was, therefore, necessary to compare the post test results of the Course Group to those of a Control Group who had not completed the course of study. For that comparison to be valid, it was necessary to establish an equivalency of the entry levels of the two groups prior to commencing the course of instruction. This measure of equivalency included data gathered from demographic information sheets completed by each participant and pretests on the subject material.

Of the original 26 students beginning the course, 10 were unable to complete the 20 lessons due to conflicts of tasks imposed by their job responsibilities. Therefore, only 16 post tests from the original 26 students in the Course Group

were used for the comparison. All 26 post tests from the Control Group were used. A breakdown of experiment participants and data sources is provided in Table 4.

The comprehensive examinations used for the pretest and post test were prepared by this researcher (Appendix E, Annexes C and D) and structured as described in section III of this thesis. While the post test had the same type of questions as the pretest, there were a larger number of short answer and essay type questions on the post test. This tended to eliminate a large portion of guessing and required that the students have a more comprehensive knowledge of the course material. [Ref. 11: pp. 3-30] Although no claim is made as to the validity of these examinations, they do represent a measure of student knowledge and achievement in relation to stated learning objectives of the course.

A. DEMOGRAPHIC DATA, ANALYSIS AND RESULTS

No prerequisites were required of students prior to taking the HFE Self-Paced course. A prerequisite established by this researcher for this study required that each student be actively involved in test and evaluation for motivational purposes.

A Student Information (SIF) sheet was distributed to and completed by each participant. Specific information included pay grade, educational level, time stationed at the test sites, job description and previous courses completed in human factors

Table 4

Breakdown of Experiment Participants and Data Sources

	Number Beginning Experiment	Number Completing 20 Lessons	Number of Valid Pretests	Number of Valid Post Tests	Number Completing ≥5 Lessons	Number Completing Questionnaires
Course Group	26	16	26	16	24	24
Control Group	26	--	26	26	--	--
Command Course Supervisors	4	--	--	--	--	4
Learning Objectives Experts	3	--	--	--	--	3

training. This demographic data for each participant is provided in Appendix F. A comparative breakdown (Table 5) between both groups was performed to specifically identify demographic characteristics which could bias the results of this study.

The distribution of enlisted personnel and officers between both groups was disproportionate with the Course Group having 50 per cent enlisted and 38.5 per cent officers compared to the Control Group's 23.1 per cent enlisted and 65.4 per cent officers. The educational level of the two groups was also unbalanced with 80.8 per cent of the Control Group having college and/or postgraduate degrees compared to the 57.7 per cent of the Course Group. Specifically significant are the percentages of those having only high school diplomas; 3.8 per cent of the Control Group, compared to 34.6 per cent of the Course Group. Additionally, the Control Group had an average of 35.9 months experience in test and evaluation while the Course Group averaged only 17.2 months. There was also a disparity in the number having participated in the test director's course offered by two of the test sites; 76.9 per cent for the Control Group and 53.8 per cent for the Course Group. All participants in this experiment were actively involved in test and evaluation.

These results caused some concern that test scores would be biased since the Control Group as a whole seemed more

Table 5

Comparative Summary Breakdown of Demographic Data
Between the Control and Course Groups

Category	Control Group n=26	Pretest Course Group n=26	Post Test Course Group n=16
Paygrade:			
E-3 -- E-9	23.1%	43.7%	50.0%
O-2 -- O-5	65.4	37.5	38.5
GS-5 -- GS-15	11.5	18.8	11.5
Education:			
High School Diploma	3.8%	25.0%	34.6%
2-3 yrs. College	15.4	6.2	7.7
College Degree	42.3	31.3	30.8
Postgraduate Degree	38.5	37.5	26.9
T & E Experience:			
Average Time	35.9 mos.	15.1 mos.	17.2 mos.
T & E Training:			
Operational Test Director's Course	76.9%	43.7%	53.8%
T & E Responsibility:	100.0%	100.0%	100.0%

experienced in performing test and evaluation, educated to a higher level, and more experienced in middle management responsibilities for test and evaluation. The actual results of the pre and post tests, however, did not substantiate this concern.

Additionally, the demographic percentages between the original 26 and the final 16 members of the Course Group who completed all 20 lessons vary insignificantly.

B. PRE-POST TEST ANALYSIS AND RESULTS

When all test participants had completed the pretest, the combined scores of all participants (Appendix F) in each of the two groups were compared. The mean score for the Control Group was 70.19 with a standard deviation of 14.85. The mean score for the Course Group was 64.73 with a standard deviation of 18.73. The following pooled variance formula for the t-test was used to test the significance of the difference in group mean:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\left(\frac{(n_1 - 1)\, s_1^2 + (n_2 - 1)\, s_2^2}{n_1 + n_2 - 2}\right)\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

Popham and Sirotnik state that this formula will result in a t-value which may be interpreted with more degrees of freedom

than other t-formulas. [Ref. 12: p. 139] Therefore, since a smaller t-value is needed to reject a given null hypothesis when a greater number of degrees of freedom are used, this formula produces a t-test that is more likely to be significant and, as a result, it is a more powerful test.

Hypothesis one assumes that the students composing the two groups do have an equivalent knowledge level prior to the entry of the experiment and, therefore, there would be no significant differences on the pretest totals of the two groups. The results of the analysis of scores are presented in Table 6.

The computed t-value was compared with a distribution of t-tables from the Students t-table. The values found indicated that for 50 degrees of freedom, the t-value of 1.74 at the .05 level of significance should be used. [Ref. 13]

The computed value of t for null hypothesis one has led to its rejection and acceptance of the alternate. Therefore, there was no significant difference between the pretest scores of the Control Group when compared with those of the Course Group. Therefore, comparing the performance of the two groups on the post test to detect any improvement by the Course Group is acceptable.

Hypothesis two states that there would be no equivalency between the post test scores of the Control Group and those of the Course Group, with the scores of the Course Group being

Table 6

Summary of Data and Analysis for Pretest Scores for the Gontrol Group and the Course Group

Control Group			Course Group			
N	MEAN	S.D.	N	MEAN	S.D.	t*
26	70.19	14.85	26	64.73	18.70	1.16

*t = ± 1.74, d.f. = 50, level of significance = .05

*t = ± 2.01, d.f. = 50, level of significance = .025

greater than those of the Control Group by at least one standard deviation. This hypothesis assumes equivalency in the scores on the pretest by both groups.

When all participants had completed the post tests, the combined scores for both goups were compared. The mean post test score for the Control Group members was 49.70 with a standard deviation of 16.48. The mean post test score for the Course Group students was 93.39 with a standard deviation of 25.14. This analysis (Table 7) resulted in a significantly high t-value. The difference between the Control Group and Course Group was demonstrated and therefore the null hypothesis two was rejected.

The post test results derived from cummulative scores of all participants (Appendix G) are provided for further study and test development. A total of 176 points was possible on the post test which covered content in the areas of (1) task analysis, (2) selection of personnel for testing, (3) workspace design and arrangement, (4) control panel design, (5) individual information processing capabilities, (6) environmental factors which may affect human performance - units of measure, (7) environmental considerations inclusive in design, (8) objectives of taking a human factors course, and (9) factors contributing to human error.

A summary of these results for the Course Group (Table 8) shows that all content area scores were at least 50 per cent of the total possible points with the exception of "Control

Table 7

Summary of Data and Analysis for Post Test Scores for the Control Group and the Course Group

Control Group			Course Group			
N	MEAN	S.D.	N	MEAN	S.D.	t*
26	49.70	16.48	16	93.39	25.14	6.816

*t = ± 1.684, d.f. = 40, level of significance = .05

*t = ± 2.021, d.f. = 40, level of significance = .025

Table 8

Summary of Content Area Cummulative Scores for Post Tests

				COURSE GROUP (n=16)						CONTROL GROUP (n=26)							
Content	Q#	Pts/ Q#	Area Pts.	Grp. Pts. Made	Grp. Pts. Poss.	Tot. Pts. Made	Tot. Pts. Poss.	%	Ind. Avg.	Grp. Pts. Made	Grp. Pts. Poss.	Tot. Pts. Made	Tot. Pts. Poss.	%	Ind. Avg.	% Δ	Ind. Δ
A	1	3		38.5	48					39.5	78						
	2	3		31.5	48					30.5	78						
	3	3		25.0	48					34.5	78						
			9			95.0	144	.66	5.9			104.5	234	.45	4.0	+.21	+ 1.9
B	1	5		66.0	80					90.5	130						
	2	4		34.0	64					0.0	104						
	3	5		33.0	80					25.0	130						
			14			133.0	224	.59	8.3			115.5	364	.32	4.4	+.27	+ 3.9
C	1	4		36.0	64					2.0	104						
	2	2		15.0	32					0.0	52						
	3	2		22.0	32					4.0	52						
	4	4		32.0	64					8.0	104						
			12			105.0	192	.55	6.6			14.0	312	.05	.5	+.50	+ 6.1
D	1	4		30.0	64					2.0	104						
	2	2		8.5	32					0.0	52						
	3	9		94.0	144					58.0	234						
	4	12		61.2	192					22.8	312						
	5	10		63.7	160					11.8	260						
	6	7		52.8	112					20.5	182						
	7	6		48.0	96					98.0	156						
	8	15		121.5	240					148.0	390						
			65			479.7	1040	.46	30.0			361.1	1690	.21	14.0	+.25	+16.0

Table 8 - Continued

Content	Q#	Pts/ Q#	Area Pts.	COURSE GROUP (n=16) Grp. Pts. Made	Grp. Pts. Poss.	Tot. Pts. Made	Tot. Pts. Poss.	%	Ind. Avg.	CONTROL GROUP (n=26) Grp. Pts. Made	Grp. Pts. Poss.	Tot. Pts. Made	Tot. Pts. Poss.	%	Ind. Avg.	% Δ	Ind. Δ
E	1	3		24.0	48					3.0	78						
	2	3		20.0	48					2.0	78						
	3	3		11.0	48					2.0	78						
			9			55.0	144	.38	3.4			7.0	234	.03	.3	+.35	+ 3.1
F	1	2		14.0	32					0.0	52						
	2	25		193.5	400					159.0	650						
			27			207.5	432	.48	13.0			159.0	712	.22	6.1	+.26	+ 6.9
G	1	5		53.0	80					70.0	133						
	2	5		50.0	80					53.0	130						
	3	6		41.0	96					11.0	156						
	4	14		149.0	224					187.0	364						
			30			293.0	480	.61	18.3			327.0	783	.42	12.6	+.19	+ 5.7
H	1	5		64.0	80					104.0	130						
	2	5		59.0	80					105.0	130						
			10			123.0	160	.77	7.7			209.0	260	.80	8.0	-.03	- .3

Panel Design", "Individual Processing Capabilities", and "Environmental Factors Affecting Human Performance" which were rated as 46.38 and 48 per cents respectively.

A summary of these results for the Control Group (Table 8) shows that only one content area (Factors Which Cause Human Error) scored at least 50 per cent. All others scored less than 50 per cent with a range of 3-48 per cent.

Additionally, the test questions were redistributed under each of the enabling objectives (Table 2) which they supported:

1. Given a list of human factors terms, write a definition for each in your own words.

2. Given a list of specific HFE problems and/or areas of concerns, identify which human factors references should be consulted to provide solutions and guidelines.

3. Given at least one control/display example, use the appropriate human factors reference to determine which features need to be redesigned.

5. Explain in your own words the importance of evaluating the human factors aspects of systems and equipments.

6. Identify the human factors principles which must be applied during the evaluation of a workspace and control/display panel.

9. Given a list of 10 factors and forces which affect human performance, identify what aspect of human performance each affects.

Table 9

Summary of Test Objective Cummulative Scores for Post Test

				COURSE GROUP (n=16)						CONTROL GROUP (n=26)							
Obj.	Q#	Pts/ Q#	Pts/ Obj.	Grp. Pts. Made	Grp. Pts. Poss.	Tot. Pts. Made	Tot. Pts. Poss.	%	Ind. Avg.	Grp. Pts. Made	Grp. Pts. Poss.	Tot. Pts. Made	Tot. Pts. Poss.	%	Ind. Avg.	% Δ	Ind. Δ
1	A1	3		38.5	48					39.5	78						
	2	3		31.5	48					30.5	78						
	3	3		25.0	48					34.5	78						
	B3	5		33.0	80					25.0	130						
	D5	10		63.7	160					11.8	260						
	6	7		52.8	112					20.5	182						
	E1	3		24.0	48					3.0	78						
	2	3		20.0	48					2.0	78						
	3	3		11.0	48					2.0	78						
	G1	5		53.0	80					70.0	133						
	4	14		149.0	224					187.0	364						
			59			501.5	944	.53	31.3			425.8	1537	.28	16.4	+.25	+14.9
2	B2	4		34.0	64					0.0	104						
	C1	4		36.0	64					2.0	104						
	D1	4		30.0	64					2.0	104						
	F1	2		14.0	32					0.0	52						
			14			114.0	224	.51	7.1			4.0	364	.01	.2	+.50	+ 6.9
3	D7	6		48.0	96					98.0	156						
	8	15		121.5	240					148.0	390						
			21			169.5	336	.50	10.6			246.0	546	.45	9.5	+.05	+ 1.1
5	D6	7		52.8	112					20.5	182						
	B1	5		66.0	80					90.5	130						
	H2	5		59.0	80					105.0	130						
			17			177.8	272	.65	11.1			216.0	442	.49	8.3	+.16	+ 2.8

Table 9 - Continued

				COURSE GROUP (n=16)						CONTROL GROUP (n=26)							
Obj.	Q#	Pts/ Q#	Pts/ Obj.	Grp. Pts. Made	Grp. Pts. Poss.	Tot. Pts. Made	Tot. Pts. Poss.	%	Ind. Avg.	Grp. Pts. Made	Grp. Pts. Poss.	Tot. Pts. Made	Tot. Pts. Poss.	%	Ind. Avg.	% Δ	Ind. Δ
6	C2	2		15.0	32					0.0	52						
	3	2		22.0	32					4.0	52						
	4	4		32.0	64					8.0	104						
	D2	2		8.5	32					0.0	52						
	3	9		94.0	144					58.0	234						
	4	12		61.2	192					22.8	312						
	5	10		63.7	160					11.8	260						
	6	7		52.8	112					20.5	182						
			48			349.2	768	.45	21.8			125.1	1248	.10	4.8	+.35	+17.0
9	F2	25		193.5	400					159.0	650						
	G2	5		50.0	80					53.0	130						
	3	6		41.0	96					11.0	156						
			36			284.5	576	.49	17.8			223.0	936	.24	8.6	+.25	+ 9.2
10	G4	14		149.0	224					187.0	364						
			14			149.0	224	.67	9.3			187.0	364	.51	7.2	+.16	+ 2.1
11	A1	3		38.5	48					39.5	78						
	2	3		31.5	48					30.5	78						
	3	3		25.0	48					34.5	78						
			9			95.0	148	.64	6.0			104.5	234	.45	4.0	+.19	+ 1.9

10. Given a list of 10 factors and forces which affect human performance, identify what unit of measure must be used to assess the amount of protection required to diminish their adverse effects upon the human operator.

All the scores for the Course Group (Table 9) rated at lease 50 per cent with the exception of Objective 6 which rated 45 per cent and Objective 9 which rated 49 per cent.

The Control Group scores (Table 9) failed to reach 50 per cent with the exception of Objective 6 which rated 51 per cent.

Since the test questions had received only minimal pre-testing, the results warrant further test item development and evaluation. Although no specific conclusions will be reported based on this preliminary analysis, it can be noted that the Course Group obtained higher scores than did the Control Group in all but one of the content areas and in all of the enabling objectives. (See right columns of Tables 8 and 9).

C. QUESTIONNAIRE ANALYSIS

Three separate questionnaires were designed and administered in accordance with NAVEDTRAs 106A, 110A and the Questionnaire Construction Manual developed for the Ft. Hood Field Unit by the U. S. Army Research Institute for the Behavioral Social Science. Summary information on the design and use of each questionnaire is provided in Table 10. Every effort

Table 10

Summary of Questionnaire Design and Use

Type	Purpose	Respon-dents	Rating Scale	Most Positive Numerical Value	Use
Student Questionnaire	Record Student's attitudes and perceptions of course materials	Course Partici-pants	Balanced Five-Pt. Likert Scale	5	Evaluation
Command Course Supervisor Questionnaire	Assessment of student atti-tudes and behav-iors during the evaluation	Command Course Supervi-sors	Numerical Interval	Varied according to statement content	Verification of student questionnaire responses
Learning Ob-jective Questionnaire	Assessment of LO construction	Subject Matter Experts	Balanced Four-Pt. Likert Scale	4	Evaluation of LOs

was made to include questions on the rating forms that the specific users were best qualified to answer.

1. Student Attitude Survey (Questionnaires)

Students who had been able to complete at least five lessons were required to complete the Student Questionnaire on various aspects of the self-paced instruction received. There were 24 students in this classification. Students were directed to answer only those questions that were applicable to the material they completed. Therefore, the reader will note that the total number of responses for each question may tend to vary.

Rating scales employed in the student questionnaires were based on a balanced five-point Likert Scale. The number of students selecting each descriptor was tabulated. Ordinal values of 1 to 5 were given to student ratings, with 5 being the most positive and 1 being most negative. These ratings were then divided into three groups and interpreted as "positive (5-4), "neutral" (3), and "negative" (2-1). The frequency of students responding to the two most positive responses was combined as was the frequency of responses for the two most negative. These figures were then translated into a percentage of the total number of students responding. The mean and standard deviation of the students' responses for each question were also calculated using the formulas listed below:

$$\bar{X} = \sum_{i=1}^{n} x_i \left(\frac{f_i}{n} \right)$$

$$S.D. = \sqrt{\frac{\sum_1 (X_1 - \bar{X})^2}{n - 1}}$$

The mean represented the degree of positiveness of the Course Group's responses to each question. These responses were used to measure their attitudes and assist in the assessment of the various aspects of the course and administrative procedures such as:

a. Course Content and Objectives
b. Course Design
c. Course Presentation
d. Student Supplement
e. Resource Documents
f. Human Factors Attitudes
g. Miscellaneous

2. Command Course Supervisor (CCS) Questionnaire and Log

Once CCS was selected from each of the four participating commands. The CCSs maintained a log throughout the evaluation period and upon its completion filled out a questionnaire.

Rating scales employed in these questionnaires were based on a numerical cell interval frequency scale. The frequency of responses was grouped into three cells:

0 - 40%

41 - 60%

61 - 100%

The CCSs estimated the frequency of student questions and comments that dealt with specific areas for each of several pertinent sections. The purpose of the data collected was to verify and clarify student questions, comments and substantiate the use of the course materials without the aid of an on-site instructor. CCSs were also directed to assess student attitudes and behaviors during the evaluation based upon their observations, student interactions and log entries. These responses were used to assist in the assessment of the following areas:

a. Lesson Book Materials
b. Student Supplement
c. Resource Documents
d. Motivation and Attitudes
e. Student Information
f. Additional Comments

3. Curriculum Development Expert Questionnaires

Three proven specialists in the field of curriculum evaluation who regularly apply the standards and criteria

provided by NAVEDTRAs 106A and 110A were asked to assess the extent that each of the terminal objectives satisfied the six criteria identified in Appendix E. The average number of years of experience for these experts was 5.5 years. All were civilians in government service whose full time job was to evaluate various aspects of curriculum prior to its validation and approval for use in the instructional systems of Navy schools.

Rating scales employed in this questionnaire were based on a balanced four-point Likert Scale. No neutral response was provided. This scale measured the degree to which each terminal objective met each of the six criteria listed in Appendix E. Ordinal values ranging from 1 through 4, were applied to the verbal descriptors as follows:

4	3	2	1
Completely	Mostly	To Some Degree	Not At All

D. INTERNAL REVIEW AND QUESTIONNAIRE RESULTS

The results for the Internal Review summarized in Chapter IV and specifically discussed in Appendix E are based on questionnaire responses from students and curriculum development experts as well as this researcher's personal evaluation.

Hypothesis three assumes that the Course Terminal Objectives, Design, Content, and Presentation would not fail to

meet the standards and criteria in accordance with NAVEDTRAs 110A and 106A.

Hypothesis four assumes that the course materials would not adversely affect student attitude regarding the need for human factors engineering test evaluation.

As is evidenced in the results which follow, the alternate hypothesis three for Course Design is rejected with the failure of the Learning Objectives to follow a logical progressive sequence which is supportive of the order of the content and lesson topics in Module 1. The layout and format are deficient in the following areas: (1) information prior to the regular progress checks at the end of the "information blocks", (2) remediation for selection of "wrong answers", (3) professionalism in the quality of the story line, (4) information in the student supplement to allow its independent usage as an HFE test and evaluation planning guide, and (5) ease and usability of the course lesson books caused by the "page flipping" aspect of the course procedures.

The null hypothesis three for Course Content, Presentation, and Design (sequencing of knowledge and skills factors contained in Module one) is rejected in as much as these areas satisfied the criteria stated in Appendix E. However, while the lesson topics in Modules 2 and 3 are not officially part of this review, it must be noted that the content failed to provide prerequisite knowledge and skills required for understanding and demonstrating follow-on concepts and skills.

The alternate hypothesis four was rejected in a much as 92 per cent of the students upon course completion, responded that HFE test and evaluation was "extremely important" (Appendix H). The students' attitudes toward human factors testing were not adversely affected.

1. Course Learning Objectives (LOs)

a. Job Task Analysis (JTA)

No approved JTA was used to develop or evaluate the LOs, as none was available. The sponsoring military commands developed a list of task requirements (Appendix B) obtained from interaction with human factors engineers. This list was provided to the course designers to guide the development of the course. This procedure is acceptable when no JTA exists.

Students assess the importance of the LOs by identifying those which they considered necessary in the planning and designing of HFE test and evaluation. The results are summarized in Table 11. With the exception of LOs 3, 4, 8, 10, 14, and 17 all the remaining LOs were judged by at least 40 per cent of the students to be important in planning and designing for HFE test and evaluation.

Students also assess the importance of the LOs by identifying those which they considered necessary in the

Table 11

Student Attitudes Regarding the Importance of the Learning Objectives in Human Factors Test and Evaluation

Proportion of Students Reporting Learning Objectives Important	Learning Objectives
50 - 100.0%	7, 11, 12, 13
40 - 49.9	1, 2, 5, 6, 9, 15, 16
30 - 39.9	3, 4, 10, 17
0 - 29.9	8, 14

performance of their job, which for most was general test and evaluation. [Ref. 3: pp. 36-38, 79-80] The results are summarized in Table 12. With the exception of LOs 8, 10, 11, 12, and 17 at least 40 per cent of the students judged the remaining LOs as important.

b. LO Criteria

The Curriculum Development Experts (CDEs) were given a questionnaire which provided a list of course LOs and asked to rate the extent to which each LO met the six previously specified criteria (Table 13). According to the results of their evaluation, no objective met the criteria "Mostly" or "Completely". It would appear that the LOs did not (1) state the objective in terms of the learner, (2) state standards, and (3) state the conditions under which learning is to occur. Most of the LOs were not behaviorally specific. Raw data is provided in Appendix I.

The alternate hypothesis three is therefore rejected with the failure of the course terminal objectives to meet the criteria identified in NAVEDTRA 106A and the absense of module (unit/section) and lesson enabling objectives.

2. Course Design

a. Sequence and Structure

Of primary importance in support of the "building block" concept of course development is the logical progression of knowledge and skill factors addressed by the terminal

Table 12

Student Attitudes Regarding the Importance of the Learning Objectives in General Test and Evaluation

Proportion of Students Reporting Learning Objectives Important	Learning Objectives
50 - 100.0%	2, 3, 7, 13, 16
40 - 49.9	1, 4, 5, 6, 9, 14, 15
30 - 39.9	10, 11, 12
0 - 29.9	8, 17

Summary of Curriculum Development Experts' Evaluation of the Learning Objectives

1. Objectives must be a statement of behavior...which can be accepted as evidence that the intended outcome has occurred

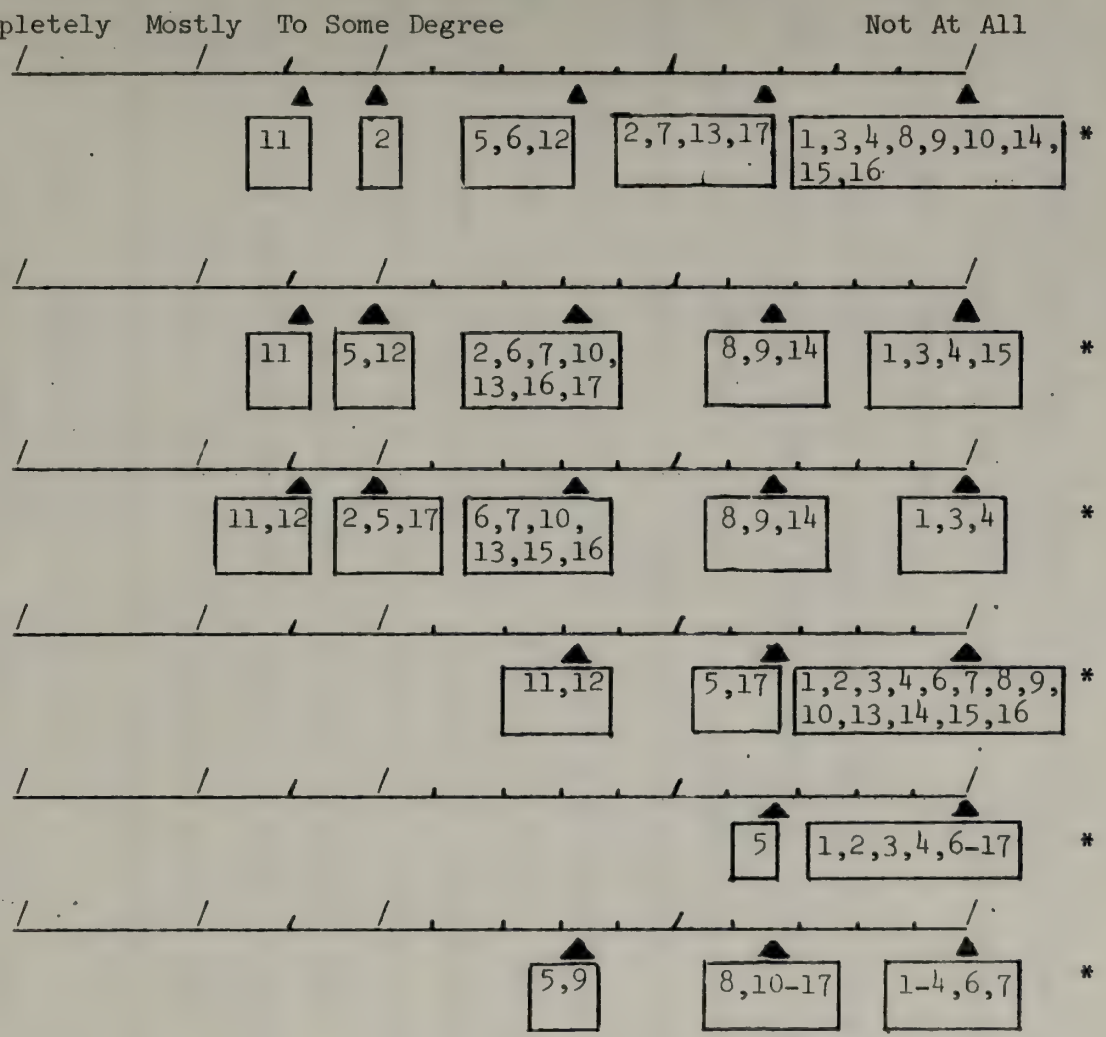
2. The behavior must describe specifically all outcomes that will demonstrate that learning has occurred.

3. The student behavior called for must be capable of observation and evaluation within the learning and testing environments.

4. The objective must be stated in learner terms rather than "teacher" terms...

5. There must be a standard against which the student behavior will be measured. It must be fully specified.

6. The statement of the conditions under which the student behavior will occur must be fully specified.



*Figures represent learning objectives as identified in Appendix C.

objectives and the course content. This also assumes that the terminal objectives will be presented in the same progressive order as the lesson topics.

To conduct this evaluation, the intent of purpose of each learning objective was identified and broken down by this researcher into four areas: (1) knowledge of concepts, (2) knowledge of skills, (3) application of knowledge and (4) application of skills. The HFE course materials were then reviewed, identifying lessons which satisfied the intent or purpose of each objective (Table 14). NAVEDTRAs 110A and 110A require that a student be tasked to perform a skill only after the prerequisite knowledge factors have been presented. This breakdown, therefore, enabled this researcher to evaluate and compare the logical progression of the terminal objectives and the lesson topics. Additionally, student attitude survey responses were assessed.

In this researcher's opinion, all 20 lesson topics within the first module appear to be supportive of the "building block" concept for development of knowledge and skills. Fifty eight and 66 per cent of student responses (Table 15) to questions B1 and B2 respectively are supportive of this opinion. In completing lessons beyond the first module, however, some discontinuity appears, i.e., statistical concepts (lessons 33 and 34) such as probability of success, confidence levels and probability of failure-free system operation are addressed in lessons 22 and 26

Table 14
Comparison of Learning Objectives Sequence and Course Content Presentation

	LEARNING OBJECTIVES	CAPABILITY	LESSONS	LESSON TOPICS ADDRESSED
1.	Terminology	Concept of knowledge (Terminology)	1 2-40	Introduction Entire course
2.	HFE references & use	Concept of knowledge (References)	1 2-40	Introduction Entire course
		Application of knowledge (Use of references)	6-40	From Anthropometry through entire course
3.	HFE technical documents	Concept of knowledge (Technical documents)	36-37	HF specifications & standards
4.	Understand HFE goals in a materiel development program	Concept of knowledge (HFE goals)	3	Tragic Mistakes & Positive Consequences
		(Materiel development program)	21	Systems Acquisition
		Application of knowledge (Demonstrate knowledge)	22	Systems Analysis
5.	Integrate HFE principles in a DOD sponsored program	Concept of knowledge (HFE principles)	6-40	From Anthropometry through entire course
		(DOD sponsored program)	21	System Acquisition
		Application of knowledge (Integrate principles into program	22	Systems Analysis
6.	Determine human performance requirements in a system concept	Concept of knowledge (Task Analysis)	23-24	Task Analysis I & II
		(Human performance requirements)	21	Systems Acquisition
		(System concept)	22	Systems Analysis

Table 14 - Continued

	LEARNING OBJECTIVES	CAPABILITY	LESSONS	LESSON TOPICS ADDRESSED
		Application of knowledge (Determine human performance requirements)	37	Testing & Human Performance Measures
7.	Understand, identify & measure factors forces	Concept of knowledge	4	Information Processing
		(Factors & forces affecting human performance)	14	Bodily Senses
			15	Vibration & Acceleration
		(Affects of those factors & forces)	16	Vigilance
			17	Temperature
		Concept of Skill	18	Atmospheric Effects
		(Measurement of factors & forces)	19	Noise
		Application of knowledge (Identify factors & forces)	40	Practical Application
		Application of skill (Measure factors & forces)		
8.	Awareness of difference between field & lab measurements	Concept of knowledge	31	Experimental Methods I
		(Field testing)	32	Experimental Methods II
		(Lab testing)		
		Application of knowledge (Demonstrate knowledge of difference between a lab and field test)		
9.	Awareness of experimental control	Concept of knowledge	31	Experimental Methods I
		(Experimental control)	32	Experimental Methods II
10.	Understand basic statistical techniques	Concept of knowledge		
		(Basic statistics)	33	Statistics I
		(Basic techniques)	34	Statistics II

Table 14 - Continued

	LEARNING OBJECTIVES	CAPABILITY	LESSONS	LESSON TOPICS ADDRESSED
		Application of knowledge (Demonstrate knowledge by interpretation)		
11.	Calculate human performance reliability	Concept of knowledge		
		(Human performance)	21	Systems Acquisition
		(Reliability)	22	Systems Analysis
		Concept of skill	25-26	Affordability & Maintainability
		(Formulas for reliability		
		Application of knowledge & Skill	37	Testing and Human Performance Measures
		(Calculation of human performance reliability)	--	Calculation--Not taught
12.	Formulate performance measures	Concept of knowledge	23	Task Analysis I
		(Task analysis)	24	Task Analysis II
		(Human performance)	21	Systems Acquisition
		(Mission identification)	22	Systems Analysis
		(Mission objectives)	37	Testing and Human Performance Measures
		Application of knowledge (Formulate performance measures)		
13.	Analyze human performance data - system reliability & effectiveness	Concept of knowledge		
		(System concept)	21	Systems Acquisition
		(Reliability)	22	Systems Analysis
		(Effectiveness)	23	Task Analysis I
		(Task analysis	24	Task Analysis II
		(Human performance)	37	Testing and Human Performance Measures
		Concept of skill	26	Maintainability
		(Formulas for reliability & effectiveness)	25	Affordability

Table 14 - Continued

	LEARNING OBJECTIVES	CAPABILITY	LESSONS	LESSON TOPICS ADDRESSED
		Application of knowledge & skill (Formulate human performance measures) (Calculate reliability & effectiveness) (Analyze - interpret results)		
14.	Understand major techniques used by HFE specialists during system synthesis, design & development	Concept of knowledge (System synthesis, design & development) (Weapons Acquisition Cycle) (HF specialist) (HF specialists' techniques) (HF specialists' involvement & responsibilities) Application of knowledge (Demonstrate knowledge by integrating the involvement of the HF specialist into the Weapons Acquistion Cycle)	21 22	Systems Acquisition Systems Analysis
15.	Familiarity with task analysis	Concept of knowledge (Task analysis)	23 24	Task Analysis I Task Analysis II
16.	Awareness of relationship between HFE and reliability, maintainability, and safety	Concept of knowledge (HFE) (Reliability) (Maintainability) (Safety)	 22 26 27 21	 Systems Analysis Maintainability Hazard Analysis Systems Acquisition

Table 14 - Continued

LEARNING OBJECTIVES	CAPABILITY	LESSONS	LESSON TOPICS ADDRESSED
	Application of knowledge (Identify relationship between specialities)		
17. Interpret & apply HFE standards & specifications	Concept of knowledge (HFE standards)	36	HF - related Specifications & Standards
	(HFE specifications)	1	Introduction
	(HFE references)	1-40	Throughout entire course
	(HFE technical documents)	6-19	Anthropometry through Noise
		22	Systems Analysis
	(HFE principles)	30	Psychophysical Methods
		6-40	Anthropometry throughout entire course
	(HFE goals)	3	Tragic Mistakes & Positive Consequences
	Concept of skill	4	Information Processing
	(HFE measurement techniques)	37	Testing & Human Performance Measures
	Application of knowledge & skill	38	Real World Problems I
	(Evaluate a system)	39	Real World Problems II
		33-34	Statistics I and II
		23-24	Task Analysis I and II

Table 15

Student Attitudes Regarding Structure of Concept Development and Sequencing of the Content Lesson Topics

Course Elements	Percentage of Students Responding			
	Positive (5-4)	Neutral (3)	Negative (2-1)	Mean
Concept Development	58%	21%	21%	3.29
Content Sequence	66	17	17	3.43

respectively. Additionally, technical references (lessons 36 and 37) such as HFTEMAN, HEDGE and MOAT are introduced in lessons 23 and 24. Students are told that more detailed information regarding these documents will be presented later. This researcher needed more information about these documents to clarify points being made in lessons 23 and 24 and was required to search for the information in lessons 36 and 37. It, therefore, becomes apparent to this researcher that modules two and three need to be reviewed to ensure that a logical progression of the knowledge and skills factors is provided.

In this researcher's opinion, the terminal objectives do not follow a logical progression as exhibited by Table 14. Specifically, LO 3 which required students' knowledge of HFE technical documents as presented in lessons 36 and 37, is sequenced before LO 4 which addresses HFE goals as presented in lesson 3. Therefore, LO 3 is out of sequence or the material in lessons 36 and 37 should be presented earlier in the sequence (prior to lessons 23 and 24). Table 14 presents other examples of incongruencies of lesson materials. Additionally, at least 50 per cent of the students responding to question A1 (Table 16) felt that objectives 1, 2, 4, and 7 were addressed within the first 20 lessons.

Since the first 20 lessons are judged to be logically progressive and the LOs are not, they therefore do not coincide in a supportive relationship. As additionally

Table 16

Student Attitudes Regarding the Learning Objectives Taught in the First 20 Lessons of the HFE Course

Proportion of Students Reporting	Learning Objectives
50 - 100.0%	1, 2, 4, 7
40 - 49.9	3, 5, 6, 14, 15
30 - 39.9	8, 9, 17
0 - 29.9	10, 11, 12, 13, 16

required by NAVEDTRA 106A, each objective must be taught within the course of instruction. LO 11 required the student to "Calculate human performance reliability" but the course does not teach the student how to do so and it was not one of the pre-course requirements.

b. Figures and Tables

All figures and tables used in the Student Supplement were rated by at least 65 per cent of the student Course Group as "positive" (Table 17). Written comments were received from participants which stated that while figures and tables were good, without the lesson books to provide additonal explanation, many of them could not be fully understood.

c. Symbols and Legends

All symbology and legends used in the Student Supplement were rated by at least 63 per cent of the Course Group as "effective" (Table 18). No additonal comments were received from students.

d. Layout and Format

Results of student attitudes regarding the effectiveness of the layout (Student Supplement, eight lesson books, and resource documents) are displayed in Table 19. Comments indicated that it did not hinder their learning experience and many indicated they preferred the way the lesson topics were divided into separate lesson books. They remarked that this added to the portability of the course

Table 17

Student Attitudes Regarding Effectiveness of Figures and Tables

Course Elements	Percentage of Students Responding			
	Positive (5-4)	Neutral (3)	Negative (2-1)	Mean
Tables	74%	26%	0	3.82
Charts	70	30	0	3.78
Graphs	65	35	0	3.74
Illustrations	74	26	0	3.83

Table 18

Student Attitudes Regarding Effectiveness of Symbology and Legends

Course Elements	Percentage of Students Responding			
	Positive (5-4)	Neutral (3)	Negative (2-1)	Mean
Symbology	52%	35%	13%	3.35
Legends	64	32	4	3.59

Table 19

Student Attitudes Regarding Effectiveness of Layout and Format

Course Elements	Percentage of Students Responding			Mean
	Positive (5-4)	Neutral (3)	Negative (2-1)	
Course Procedures	50%	8%	42%	2.92
Information presented before questions	50	38	12	3.42
Information presented after questions	29	59	12	3.21
Quality of Reinforcement (Wrong-answer frames)	30	39	31	2.87
Quality of Questions at end of information frames	50	42	8	3.42
Quality of Story Line	16	42	42	2.54
Stand-alone value of Student Supplement	25	42	33	2.86
Quality of Answer Choices	46	42	12	3.29

materials. Additonally, the students felt that much of the material in the Student Supplement had to be clarified by information in the lesson books. It would therefore, be very difficult to use the Student Supplement as a stand-alone reference and planning guide for HFE test and evaluation. They considered its value as negligable once the student lesson books were returned to the sponsoring agency upon completion of the course.

Regarding the format, no less than 50 per cent responded positively to (1) Course Procedures, (2) Information Blocks, and (3) Quality of Questions. It must be noted that both course procedures and quality of story line received a negative rating by 42 per cent of the students. Written and verbal comments from participants indicated a strong dissatisfaction with "page flipping" aspect of the course procedures to search for answers as well as an equally strong dislike for the story line following the antics of the ficticious Lt. I. M. Eager.

Addtional amplifying information regarding layout and format were extracted from written comments on the questionnaires and verbal comments recorded by the CCSs. These have been paraphrased or quoted directly when found to be representative of the majority of the course participants.

(1) As a group, course participants felt that the information frames sometimes did not provide all the information necessary to answer correctly the questions at the

end of the information frame. In fact, comments reported that sometimes the information was not given until the following frame.

(2) The reinforcement provided in the "wrong answer frames" was judged to be borderline. Students also commented that the wrong answer replies were demeaning, i.e., "Surely, you didn't answer that way". "A simple 'correct' or 'incorrect' with some amplifying information will suffice." was a comment which was representative of a majority of the students.

(3) The quality of the questions asked at the end of the "information frames" was considered borderline. Comments from students indicated that sometimes the questions could be answered by elimination of "ridiculous answer choices" while others had to be guessed. Some participants felt that the questions were unclear or worded poorly so as to cause confusion.

(4) Several students responded that problems such as those already mentioned as well as errors in the course materials caused endless loops resulting in irritation and loss of motivation for continuing with the course. As one student stated "I would have quit by lesson five, if I hadn't been assigned to complete the course."

(5) While student questionnaires indicated the format was neutral, fifteen of the 24 students polled chose to write comments concerning their dissatisfaction with the

"page flipping" format. They reported losing their places and having to begin again from frame one of the chapter being studied. This format may have prevented looking ahead, but it most certainly "prevented review of any materials". Judging from the forcefullness and emotion emanating from actual comments, the following quote sums it up, "In all the service schools and courses which I have attended and taken in the past years, programmed texts were an integral part of the curriculum. I have never seen a programmed text structured such as this one. In all honesty, after the first 25 pages, my interest level dropped to zero and remained there. Thumbing through numerous pages to find correct answers or incorrect answers and then constantly repeating the procedure... created a frustrating situation that stifled any learning. This page shuffling drill detracted from any tangible benefits that might have been derived from the material presented."

(6) The inclusion of a story line following the adventures of the ficticious Lt. I. M. Eager and his buddy-boss, Capt. B. Smart was not accepted well by course participants. Of all the questions answered, the effectiveness of the story line was rated the lowest. While the numerical value of the mean places it at the "neutral" point, it does so by only .04 of a point away from "negative".

(7) Fourteen of the students reported that the story sequence was sometimes disjointed and very much distracting from learning the essence of the lessons. Overall,

they indicated a desire to "drop the junk and put more facts" "and real life examples in its place." "The stories made the text too 'cute', don't try to entertain me in a course, try to teach me. The way the material was presented (using Eager) just irritated me and the effectiveness of the course was diminished."

3. Course Content

In addition to the overall effectiveness assessment provided from the diagnostic test results, an important indicator of the perceived value of the course content was the number of students desiring to keep copies of the Student Supplement and the lesson books (Table 20). Forty-two per cent of the course participants desired to keep a copy of the course materials and 54 per cent wanted to keep the Student Supplement.

Table 20

Student Attitudes Regarding Retaining a Copy of the HFE Course Materials for Future Use

Responses	Percentage of Students Responding	
	Yes	No
Want to keep course materials?	42%	58%
Want to keep supplement only?	54	46

4. Course Presentation

The percentage of student attitudes regarding the effectiveness of the course length (Table 21) was calculated with 52 per cent responding positively and 26 per cent negatively. Percentages of those regarding terminology used were 65 per cent positive and 9 per cent negative. Responses regarding participation in the course without the aid of an on-site instructor were relatively evenly distributed with 37 per cent positive and 34 per cent negative.

Regarding the latter set of responses, it is believed that contacting the CCS (who was not HFE trained) for exchanging books and receiving tests and questionnaires may have been interpreted by students as contact with an on-site instructor. The CCSs' logs indicated that students seldomly, if ever, required their assistance with course content in the role of an on-site instructor. Additionally, this researcher received no communication from students asking for clarity of course instructions or content, even though it was encouraged in students' instructions.

It must also be pointed out that 42 per cent of the course participants desired to keep a copy of the course lesson materials, even though they had been informed that no assistance would be available upon completion of the evaluation period.

Additional amplifying information regarding course presentation was extracted from written comments on the

Table 21

Student Attitudes Regarding Effectiveness of Course Presentation

Course Elements	Percentage of Students Responding			Mean
	Positive (5-4)	Neutral (3)	Negative (2-1)	
Length of Course	52%	22%	26%	3.43
Terminology	65	26	9	3.48
Participation without aid of an on-site instructor	37	29	34	2.92

questionnaires and verbal comments recorded by the CCSs. These have been paraphrased or quoted directly when representative of the majority of the course participants:

a. The level of detail presented throughout the course materials presented no difficulty in content comprehension according to student reponses in the questionnaires. Some comments were made which indicated that students would like to see an even greater detail for some areas, however, they were not specific as to which areas.

b. No negative comments were received regarding the course length. The time required for course participation was not overburdening to them. However, students felt that the format caused time to be wasted which could have been spent on the course content.

c. The only feedback students received while taking the HFE course was provided in the answers at the end of each information frame. No periodic self-check tests were available with the course materials. According to the course sponsors, none have as yet been developed. The sponsors had intended that measurement of the students' attainment of the course LOs would not be necessary as their mastery of the content would become apparent as it was applied in the normal performance of their jobs in designing and implementing tests for evaluation of the human factors aspects of equipments and systems.

5. Course Availability

According to the course sponsors, original plans called for the U. S. Army to supply all necessary materials to its own personnel, while the cognizant Navy commands would fulfill Navy requests, once the course was finalized. However, present constraints on budget and personnel to make corrections and implement the computer program may hinder, if not prevent, this effort.

6. Course Maintainability

Future plans of perceived needs in this area cannot be reported, as none were received from the sponsoring commands. However, even during this preliminary evaluation, its importance was clearly noted. At present, course materials refer to specific pages of MIL-STDs and handbooks which caused some confusion to course participants when using MIL-STD 1472C. The HFE course makes references to specific pages within MIL-STD 1472B. In the latest version of the MIL-STD, the pages had been renumbered and students stated that there was some difficulty in finding the correct figure or information they were assigned to read. Additionally, the United States has converted their measuring system to metrics and this is not reflected within the course materials.

7. Course Supportability

Future plans of perceived needs in this area cannot be reported as none were provided from the sponsoring commands. At present, supporting commands remain to be identified.

V. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

The Human Factors Engineering Self-Paced Course has the potential to be most effective, based on its demonstrated ability to successfully provide the stimuli for the transfer of knowledge and skills to the Course Group in support of the intent of the course originators' task requirements and terminal objectives. The incorporation of the recommendations provided below would provide the course the potential to pass a validation attempt in accordance with CNTECHTRA requirements.

Further validation of course content validity should include a study of the Course Group participants after having had the opportunity to apply their newly gained knowledge and skills in the performance of their jobs in designing and conducting human factors tests.

B. RECOMMENDATIONS

It is recommended that the course designers/sponsors comply with the standards and criteria identified by CNTECHTRA in NAVEDTRAs 110A and 106A for the development of military educational courses and incorporate the following changes into the Human Factors Engineering Self-Paced Course.

1. Course Learning Objectives

Rewrite and rearrange course terminal objectives and develop lesson and module enabling objectives. Incorporate the elements required for acceptable learning objectives which appear to be missing from those presently given for this course: (1) specific description of expected learner action, (2) conditions under which the action will take place, and (3) standards or criterion which must be reached by the students. Evaluate them again according to the six criteria required by NAVEDTRA 106A. The 17 course terminal learning objectives have been restructured (Table 22) to meet the criteria. The learning objectives should, however, be presented in the same order as the course content. A recommended reordering of the course's original terminal objectives have been provided in Table 23.

2. Course Design

a. Sequence of Course Content.

Reevaluate the sequence of the content as it is presently given to ensure that knowledge and concepts are taught before the students are required to apply them, i.e., task analysis before human performance evaluation. This will support the "building block" concept of learning skills and provide the student a better opportunity to attain success and avoid unnecessary frustrations.

b. Layout of Student Supplement and Lesson Books.

Follow the guidelines provided in NAVEDTRA 110A which addresses the proper physical layout and required

Table 22

Examples of Recommended Restructured Terminal Learning Objectives IAW NAVEDTRA 106A

1. Define in writing common terms used in human factors engineering in accordance with lessons 1-40.

2. Given a list of HFE reference documents, select the major topics addressed by each in accordance with lessons 1-40.

3. Given an HFE problem, demonstrate the ability to resolve it by correctly selecting the HFE reference and locating within its contents the section which provides the necessary information in accordance with lessons 1-40.

4. Describe in writing the basic goals of HFE in a materiel development program in accordance with lessons 1-4.

5. Describe in writing the inter-relationships of the four major factors of HFE in a materiel development program i.e., human performance requirements, personnel selection criteria, training and equipment design in accordance with lessons 1-4 and 28-29.

6. Given the stages of the basic systems acquisition cycle, describe in your own words the level of involvement an HFE designer and evaluator should have at each point. Include in your discussion the purpose of your testing and the basic steps you would follow to become involved at each stage. Responses should be in accordance with lessons 21 and 22.

7. Discuss in writing the importance and purpose of evaluating human factors in a systems concept rather than just evaluating the operator or the machine individually in accordance with lessons 2, 21, and 22.

8. Given an HFE proglem, analyze systems concept employing task analysis and/or determine the human factors requirements which must be considered when designing the piece of equipment in accordance with lessons 6, 7, 14, and 21-24.

9. Given an HFE problem, identify 3 factors and 3 forces which would affect human performance and describe how you would measure each, i.e., what equipment to use and what

unit of measure is appropriate, in accordance with lessons 9, 10, and 15-19.

10. Discuss in writing the differences between HFE measurements taken in the field and those later in a laboratory setting. Include in your discussion the potential difficulties of applying generalized laboratory data to field situations, in accordance with lessons 31 and 32.

11. Discuss in writing the importance of performing testing both in a controlled environment and that in the "real world". Responses are to be in accordance with lessons 31 and 32.

12. Given a list, identify the "experimental control" measures necessary in any test involving the human performance and describe the probable effects on the test data if they are absent, in accordance with lessons 31 and 32.

13. Given an HFE problem with human performance data available calculate system performance reliability and assess the potential effectiveness of the system. Round your answer to the nearest thousandths. Responses are to be in accordance with lessons 21, 22, 26, 33 and 34.

14. Given three different examples of a task analysis for the same piece of equipment, select the one which is done correctly, in accordance with lessons 23 and 24.

15. Given an HFE problem, determine performance measures for the dependent variables of time and error in accordance with lessons 33 and 34.

16. Describe the relationship between human factors engineering and the engineering specialties of reliability, maintainability and safety in accordance with lessons 25-27.

17. Given an HFE problem, state the HFE standards and specifications necessary to evaluate human performance in accordance with the guidelines and reference documents presented in lessons 21 and 22.

18. Interpret the data given in an analysis of variance table performance scores from an experiment having three independent variables with one statistically significant first order interaction, in accordance with lessons 33 and 34.

Table 23

Recommended Resequencing of the Human Factors Engineering Self-Paced Course Terminal Learning Objectives

Upon completion of the Human Factors Engineering Course, the student will demonstrate the following capabilities and knowledge:

1. An understanding of common terms used in human factors engineering.

2. A familiarity with human factors references and an ability to use them.

3. An awareness of potential sources of technical information on major human factors topics.

17. An ability to interpret the standards and specifications of the human factors engineering community, through the use of HFE references.

4. An understanding of the goals of human factors engineering in a materiel development program.

5. A familiarity with the acquisition cycle.

7. An understanding of the kinds of factors and forces which affect human performance and an ability to identify them.

15. A familiarity with task analysis.

7. An ability to measure the factors and forces which affect human performance.

10. An understanding of basic statistical techniques, such as an analysis of variance.

12. An ability to formulate performance measures for the dependent variables of time and error.

11. An ability to calculate human performance reliability.

5. An ability to integrate human factors principles in a DOD sponsored program.

14. An understanding of the major techniques used by human factors specialist during system synthesis, design, and development.

6. An ability to determine human performance requirements in a systems concept.

13. An ability to analyze human performance data within the context of "system effectiveness" and "system reliability".

16. An awareness of the relationship between human factors engineering and the engineering specialist of reliability, maintainability and safety.

8. An awareness of the differences between field and laboratory measurements.

9. An awareness of what "experimental control" measures are necessary for any test involving human performance and the effects in their absence.

17. An ability to apply the standards and specifications of the human factors engineering community.

elements of module (lesson) booklets and lesson topics:

(1) Instructional materials are required to have a specific numbering system which clearly shows the relationships between terminal objectives, enabling objectives and course content.

(2) Each module booklet is required to have a cover page, module overview and lesson topics. Samples of the module overview and cover page are provided in Appendix I.

(3) Lesson topics cover, wholly or in part, terminal objectives. Progress checks (self-tests) are provided for the student at the end of lesson topics to measure their ability to achieve the terminal objectives and determine the need for remediation.

(4) Each lesson topic shall contain the items listed below:

Lesson Topic Cover Page*
Lesson Topic Overview*
List of Study Resources
Lesson Topic Summary
Narrative Form of Lesson Topic
Programmed Instruction Material
Lesson Topic Progress Check, complete with feedback and remediation.

Samples of those items asterisk'd above are provided in Appendix J.

c. Format of Course Lesson Books

(1) Review "information frames" and questions to ensure that sufficient information has been provided to answer the questions before they are asked, i.e., Lesson 15, page 84, "frame from page 80"; Lesson 17, page 68, "frame from page 67".

(2) Review "wrong answer frames", increase professionalism in replies and provide reinforcement by directing the student to a specific area to help choose the correct answer on the next try, i.e., Lesson 12, page 68 "(3) We know you don't know, but we want you to give it a shot. Return to page 39...".

(3) Review the quality of the question asked. Rewrite those which are ambiguous, require guessing or really offer no doubt as to the answer because of the examples provided in the wording of the answer choices, i.e., Lesson 13, page 96, "frame from page 93".

(4) Review the story line using the ficticious Lt. I. M. Eager and if it is decided to maintain the story line, upgrade the examples and remove extraneous portions which do not add to the content of the course. Provide more "real world" examples which could add greater meaning and clarity to the content.

(5) Change the "page flipping" format of the written version of the course. The U. S. Navy correspondence courses provide an acceptable format and one with which some

military personnel are already familiar. Another popular format is used in the Elementary Algebra: Lecture Lab by Arthur H. Heywood.

3. Course Content.

a. Review course content to be sure that the tasks identified in the learning objectives are adequately addressed, i.e., calculation of reliability.

b. Correct clerical errors, i.e., Table 33.5 of Student Supplement; Lesson 20, page 74, says "frame from page 71" when it should read "...page 24"; Lesson 19, page 91, frame from page 26: reads "By finding the point of ... between four hours...", should read "...two hours".

4. Course Presentation.

a. Provide student self-check tests following each lesson topic and following each module with a final comprehensive test upon course completion (after the course review). The questions at the end of each information frame don't allow the student to adequately evaluate their understanding or acquisition of the necessary concepts and skills. Include reinforcement for end-of-information-frame tests by referring the student to the appropriate sections for review based on students' incorrect answers.

b. Provide course tests so that students can judge how well they had attained the course learning objectives before they attempt to apply it in their normal jobs. This will

allow them to go back and review the areas in which they are weak. A certificate of completion and credit can then be awarded upon satisfactory completion of the course. Completion of the course may also be made a part of each command's qualification procedures.

5. Course Availability, Maintainability, and Supportability.

a. Provide plans and estimates required for future implementation of the HFE Course and an outline of the necessary support in those areas as specified in NAVEDTRA 110A.

b. Update this version of the course to be consistent with MIL-STD 1472C vice MIL-STD 1472B. When referencing material within any of the reference documents used within the course, do not use page numbers; provide section numbers instead. Addtionally, make references more specific when dealing with MIL-STD documents; do not just refer to the document as a whole when addressing a specific section.

c. Recommend a schedule of periodic course review and updates as indicated by NAVEDTRA 110A.

VI. SUMMARY

As this study indicates, the Human Factors Engineering Self-Paced Course has the strong potential for providing the stimuli to transfer knowledge and skills to its students. Whether this course provides sufficient content to effectively bridge the gap between the military technical documents and standards to allow for their increased usage by evaluators on the job is an area for further study.

There is an interesting side note relative to the low level of human factors familiarity by all experiment participants as indicated by the results on the pretest: could this possibly be substantiation to the claim made by GAO in their report to the U. S. Congress [Ref. 1: pp. 1-27] which has been referenced periodically throughout this thesis?

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APPENDIX A.

RESOURCE DOCUMENTS SUMMARIES

A brief summary of the various military standards, handbooks, and documents required for use by the Human Factors Engineering Self-Paced Course participants is provided within this Appendix:

1. MIL-H-46855B
2. MIL-STD-1472C
3. MIL-STD-1474B
4. MIL-HDBK-759
5. Army Regulation 602-1
6. Technical Memorandum 29-76

Additonally, summaries or copies of the abstracts are provided for documents to which the Human Factors Engineering Self-Paced Course referred, but are not essential for course completion:

1. MIL-STD-721B
2. FED-STD-595
3. Guide to Human Factors Engineering General Purpose Test Planning (GPTP)
4. HFTEMAN
5. HEDGE
6. MOAT

REQUIRED DOCUMENTS

1. MIL-H-46855B Human Engineering Requirements for Military Systems, Equipments and Facilities

"MIL-H-46855B establishes and defines the overall requirements for applying the human engineering priciples and criteria presented in MIL-STD-1472C during the procurement of military systems, thereby effectively integrating man into the system. The specification requires the prospective contractor to state his approach in his Human Engineering Program Plan which is submitted in response to the Request for Proposal (RFP). The Human Engineering Program Plan, upon acceptance of hte proposal, becomes part of the procurement contract.

The three major areas of the system acquisition process where these human factors engineering principles are to be employed are analysis, design and development, and test and evaluation. The objectives of analysis are identification and definition of system operations, maintenance, training and control functions; allocation of these functions to man and/or machine; analysis of the tasks comprising these functions; and development of system specific human engineering design criteria and operation and maintenance procedures. The human engineering inputs developed in the analysis phase and comensurate with MIL-STD-1472C are to be incorporated into the detailed design. These human engineering provisions shall be evaluated during the design reviews to ensure their adequacy. The purpose of the test and evaluation phase is assurance of the fulfillment of MIL-H-46855B and contract requirement, demonstration of conformance to MIL-STD-1472C quantification of man-machine system performance, and indication of the introduction of possible undesirable design or procedural features.

MIL-STD-1472C and MIL-H-46855B are complementary directives that deal with requirements for implementation of human factors engineering principles in the development and acquisition of military systems, equipment and facilities. The former establishes the criteria by which the systems are to be human engineered, and the latter establishes the requirements for maintenance and maintainability as integral parts of the human engineering of the total system."

2. MIL-STD-1472C. Human Engineering Design Criteria for Military Systems, Equipments and Facilities.

"This standard establishes general human engineering criteria for development of military systems, subsystems, equipment and facilities.

The purpose of this standard is to present human engineering design criteria, principles, and practices to achieve mission success through integration of the human into the system, subsystem, equipment, and facility, and achieve effectiveness, simplicity, efficiency, reliability, and safety of system operation, training, and maintenance.

More specifically, its purpose is to present human engineering design, criteria, priciples and practices to be applied in the design of systems, equipment and facilities so as to:

a. Achieve required performance by operator, control and maintenance personnel.

b. Minimize skill and personnel requirements and training time.

c. Achieve required reliability of personnel-equipment combinations.

d. Foster design standardization within and among systems.

The standard includes a compilation of anthropometric data from several military sources (MIL-STD-721B, MIL-STD-1474B and FED-STD-595), an extensive collection of control/display design criteria, hazard and safety considerations, and requirements for certain specialized systems which may also be applied to such equipments as ground vehicles, remote handling devices, air and ship crew stations."

3. MIL-STD-1474B Noise Limits for Army Materiel

"Three distinctly different types of 'noise criteria' which are used to limit noise exposure have evolved over the years. It is important to distinguish among the three types in order that the proper type may be chosen for application and use in various situations. The three types of noise criteria are:

a. Hearing damage-risk criteria
b. Hearing conservative criteria
c. Materiel design standards

This document is a design standard for noise. It is based on provisions of TB-MED-251 with respect to noise exposure criteria. MIL-STD-1472C extracts communications criteria from it."

4. MIL-HDBK-759. Human Factors Engineering Design for Army Materiel.

"This handbook gives the design engineer both human factors engineering design priciples and detailed criteria. The design principles are stated as general rules to be applied during system-development programs or as essential items that must be considered during design to insure that sound human factors engineering practices will be incorporated. The detailed criteria consist of dimensions, ranges, tolerances, and other specific data. In some cases, the range of acceptable dimensions and other factors may be rather large. Where only the minimum and maximum are given, design engineers may select any part or item within the recommended range. But where optimum dimensions are given, designers should aim to approximate them whenever possible.

The purpose of this document is to establish in handbook form general data and detailed criteria for human factors engineering application in the design and development of army materiel.

The information in this handbook is a consolidation of the material contained in four U. S. Army Human Engineering Laboratory Standard Documents; HEL S-2-64A, S-3-65, S-6-66, and S-7-68. The user will also note the similarities of this document with MIL-STD-1472C."

5. Army Regulation 602-1. Personnel-Materiel Systems: Human Factors Engineering Program. Washington, D. C., June 1976.

"This regulation prescribes policies and procedures and assigns responsibilities for human factors engineering (HFE) in the Department of the Army. For the purpose of this regulation, HFE is defined as a comprehensive technical effort to integrate all personnel characteristics (skills, training implications, behavioral reactions, human performance, anthropometric data and biomedical factors) into Army doctrine and systems to assure operational effectiveness, safety, and freedom from health hazards."

6. TECHNICAL MEMORANDUM 29-76. Guide for Obtaining and Analyzing Human Performance Data in a Materiel Development Project.

"The specific objectives of this report are to: (1) describe how to conduct and report an HFE test according to the requirements of DI-H-1334A, (2) detail the expenditures in time and money associated with the conduct of an HFE test,

(3) provide examples of HFE test reports for systems in "experimental prototype" and "advanced development" phases of development, (4) describe the uses of the obtained HFE test data as a function of system development, and (5) explain the impact of the DI-H-1334A findings on a materiel development program.

This document is written for government contract monitors, contract project directors, and contractor HFE personnel. The guidelines for conducting and reporting on the HFE test are intended for experienced HFE personnel.

Questions of what data are to be collected, how they are to be collected, and how the data can be used are discussed in Chapters 2, 3, and 4 of this report. Chapter 2 is a guideline for planning, conducting, analyzing, and reporting on an HFE evaluation according to the requirements of DI-H-1334A. Procedures for managing the HFE evaluation, allocating test personnel, developing test cost estimates, etc., are also contained in Chapter 2. This information will aid project managers in the administration and organization of an HFE evaluation. The explanations of the DI-H-1334A requirements will assist the contract monitor to understand and monitor HFE tests and ensure that all of the requirements of DI-H-1334A are satisfied.

Chapters 3 and 4 supplement the guidelines given in Chapter 2 by giving detailed examples of HFE reports, written according to the requirements of DI-H-1334A. Chapter 3 presents the HFE test report of a system in the experimental prototype stage of development. This sample HFE report focuses on determinining the feasibility of human performance, the appropriateness of the tasks allocated to the operator and to the machine, and the adequacy of the workspace layout. This report also demonstrates procedures for conducting HFE tests and mock-up equipment.

Chapter 4 contains the HFE test report of an advanced development prototype. The emphasis in this stage of development is on determining the capability of the operator to perform his assigned tasks within his prescribed time and error standards. This test report also evaluates the adequacy of operator selection and training, as well as the equipment configuration.

Chapter 5 discusses implications of human performance tests. The uses to which data can be applied and the problem associated with conducting HFE tests are also described. By describing how HFE test data can be applied and the benefits of collecting the data, program managers can better appreciate the need for HFE testing."

RECOMMENDED DOCUMENTS

1. MIL-STD-721B Definitions of Effectiveness Terms for Reliability, Maintainability, Human Factors and Safety

"Applying effectiveness terminology within the Department of Defense and industry requires good communications and coordination which, in turn, requires common definitions and terminology. This Standard lists and defines words and terms most commonly used in reliability, maintainability, human factors and safety. Statistical and mathematical terms which have gained wide acceptance are not defined in this Standard since they are included in other documents, e.g., MIL-HDBK-217.

The following criteria were used for the inclusion of terms and definitions deemed pertinent to the scope of this Standard:

a. Terms and their definitions which are:

(1) Important in procurement of weapon systems for precise definition of effectiveness criteria.

(2) Unique in their definition, allowing no other meaning.

(3) Expressed clearly, preferably without mathematical symbols.

(4) Fully explanatory, without reference to any other source documents.

b. Terms that were avoided include:

(1) Those found in ordinary technical, statistical, or standard dictionary or text having a singularly acceptable meaning when used in the context.

(2) Terms already existing in other Military Standards outside of the project scope.

(3) Multiple word terms, unless needed for uniqueness.

c. The purpose of this Military Standard is to standardize on meanings of terms for the particular application, not to compile a handbook.

2. FED STD 595 Colors

"The purpose of this standard is to present in covenient form a collection of standard colors currently used by the various departments of the Government. These standard colors, identified by 5-digit numbers, are defined by fundamental colorimetric data. For reference purposes, each color is reproduced within a 1/2 x 1 inch chip. For procurement, inspection and other color matching purposes, 3 x 5 inch color chips are issued as specific standards. These chips are identified by the same 5-digit numbers.

Spectrophotometric curves and Commission Internationale de l'Eclairage (CIE) data for each chip are included as Volume II to this standard. These are to be used as basic standards for reproducing future issues of the chips, also for determining changes which may, or may not, have occurred in chips in stock. The spectrophotometric curves and CIE measurements may also be used for acceptance testing purposes in lieu of the 3 x 5 inch chips if so specified. However, accurate comparison can be made only if values and curves are obtained on the same instrument standardized under the same conditions."

3. Guide to Human Factors Engineering General Purpose Test Planning (GPTP)

"This report is concerned with human factors engineering test and evaluation program planning, which is generalizable across naval weapons systems except for nuclear weapons and propulsion subsystems. The Test and Evaluation Program Planning Guide is prepared for use by test planners and is in accordance with DOD Directive 5000.3, NAVMATINST 3900.0, NAVMATINST 3960.6, OPNAVINST 3960.10, and OPNAVINST 4720.9. The human factors engineering Test and Evaluation Program Plan specifically addresses developmental and operational tests as well as production acceptance tests to provide data for satisfying the Defense System Acquisition Review Council milestones for system acquisition."

4. HFTEMAN Human Factors Test & Evaluation Manual, Vols. I, II, and III

"In most military systems the ultimate effectiveness of the system depends on the capability of the human to operate, maintain, transport, erect, or otherwise use the system equipment.

In the test and evaluation of such systems adequate consideration must be given to the human element.

Human Factors Test & Evaluation Manual was developed to assist Navy and Marine Corps Test and Evaluation personnel in the evaluation of the human factors aspects of equipment items.

Human Factors Test & Evaluation Manual is primarily directed toward the Human Factors Engineering (HFE). The detail provided for the Test and Evaluation Plan:

-- Guidelines concerning what to evaluate.

-- Standards or criteria to evaluate against.

-- Planning information on how to design, setup, conduct, and analyze data from a human factors enginering test or evaluation.

Human Factors Test & Evaluation Manual is therefore used when the detail Test and Evaluation plan is being generated. It enables the planner to identify HFE:

-- Test objectives.

-- Test methods, procedures and conditions.

-- Test measurements to be acquired and recorded during the test or evaluation.

-- Criteria or standards against which measurements are compared.

-- Test data collection materials such as questionnaires or checklists.

-- Test data analysis, presentation and reporting requirements.

Human Factors Test & Evaluation Manual consists of three volumes:

-- Volume I - Data Guide: contains the guidelines concerning what to evaluate for different classes of equipment and types of tests.

-- Volume II- Support Data: contains additional criteria expanding on the guidelines contained in Volume I.

-- Volume III-Methods and Procedures: contains guidance on how to design, set up, conduct and analyze data obtained in HFE Test & Evaluation program.

5. Human Factors Engineering Data Guide for Evaluation (HEDGE)

"The purpose of the information in HEDGE is to enable you to expand your test capabilities in considering the human element. They will provide you with a strategy for viewing any item which is undergoing testing from the standpoint of the soldier who must ultimately operate, maintain, or otherwise utilize it. The use of these materials, in addition to standard Task and Design Checklists and Questionnaires, will enable you to tailor your HFE subtest to a specific item.

These materials have been prepared especially for you:

a. They are intended to support test engineers not design engineers.

b. They were designed with your specific tasks in mind, i.e., preparing a Test Plan, conducting a test, analyzing and interpreting test data, and generating the test report.

Because these materials offer you a strategy for conducting human factors testing rather than a compendium of facts, the results which you obtain will be directly proportional to your intelligent and common sense application of the data presented."

6. Mission Operability Assessment Technique: A System Evaluation Methodology (MOAT)

"The MOAT is an evaluation methodology that measures the operability of a system or subsystem in terms of operator tasks performed during a mission. MOAT addresses the problem of how well an operator can use a system or subsystem to perform tasks within the mission context. Contrasted to evaluations using human engineering design criteria which present only pass or fail information, this technique provides information on the degree of system and/or subsystem success or failure. This report discusses how MOAT was developed, how MOAT can be used on existing or emerging systems, and how MOAT will be expanded in future development to include multicrew station evaluations. This report examines how the three underlying technologies have been integrated into one comprehensive methodology. Task analysis, scaling methodology, and multi-attribute utility theory are discussed in terms of MOAT development and application. Finally, the report discusses the importance of developing systems evaluation methodologies which provide decision makers with meaningful information necessary for effective decision making."

APPENDIX B.

HUMAN FACTORS ENGINEERING SELF-PACED COURSE TASK REQUIREMENTS

Upon completion of the HFE Course, students should know:

1. The meaning of common terms used in human factors engineering.

2. The principal HFE references (regulations, standards, specification, guides, etc.) and where in them to look for the answers to specific types of HFE problems.

3. Potential sources of technical information on major topics within human factors engineering.

4. The goals of HFE in a materiel development program (i.e., the compatibility of the four factors: human performance requirements, personnel selection criteria, training and equipment design).

5. When, how, and for what purpose in the general scheme by which the Department of Defense (DOD) develops materiel human factors engineering activities should be performed.

6. How to determine the human performance requirements in a systems concept.

7. The kinds of factors and forces which can affect human performance and how to identify and measure them.

8. The differences between measurements taken in field vs. laboratory settings, and the difficulties of generalizing laboratory data to field situations.

9. How to formulate and then state in comprehensible English performance measures applicable to a specific system for the general dependent variables of time and error.

10. What "experimental control" measures are necessary in any test involving human performance and the probable effects on test data if they are absent.

11. How to analyze human performance data (e.g., time and error) within the context of "system effectiveness" and "System reliability".

12. How to calculate human performance reliability.

13. The major techniques used by human factors engineers during system sythesis, design and development.

14. How to recognize a good task analysis.

15. The relationship between human factors engineering and the engineering specialities of reliability, maintainability and safety.

16. How to interpret and apply the standards and specifications needed for human factors engineering that deal with human performance.

17. The correct method of stating criteria for a vehicle which must be inaudible 100 meters away from it, and for an alarm which must be audible for 500 meters.

18. How to determine the minimum height of letters on a sign which must be visible at 100 meters on a sunny day.

19. How to interpret an analysis of variance table of performance scores in an experiment having three independent variables with one statistically significant main effect and one statistically significant first-order interaction.

APPENDIX C.

HUMAN FACTORS ENGINEERING SELF-PACED COURSE TERMINAL LEARNING OBJECTIVES

Upon completion of the Human Factors Engineering Self-Paced Course, the student will demonstrate the following capabilities and knowledge:

1. An understanding of common terms used in human factors engineering.

2. A familiarity with human factors references and an ability to use them.

3. An awareness of potential sources of technical information on major human factors topics.

4. An understanding of the goals of human factros engineering in a materiel development program.

5. An ability to integrate human factors priciples in a DOD sponsored program.

6. An ability to determine human performance requirements in a systems concept.

7. An understanding of the kinds of factors and forces which affect human performance and an ability to identify and measure them.

8. An awareness of the differences between field and laboratory measurements.

9. An awareness of what "experimental control" measures are necessary for any test involving human performance and the effects in their absence.

10. An understanding of basic statistical techniques, such as an analysis of variance.

11. An ability to calculate human performance reliability.

12. An ability to formulate performance measures for the dependent variables of time and error.

13. An ability to analyze human performance data within the context of "system effectiveness" and "system reliability".

14. An understanding of the major techniques used by human factors specialists during system synthesis, design, and development.

15. A familiarity with task analysis.

16. An awareness of the relationship between human factors engineering and the engineering specialists of reliability, maintainability, and safety.

17. An ability to interpret and apply the standards and specifications of the human factors engineering community.

APPENDIX D.

HUMAN FACTORS ENGINEERING SELF-PACED COURSE LESSON TOPICS OUTLINES[6]

Lesson 1: Welcome to Human Factors Engineering

I. Course Introduction

II. Importance of Human Factors

Lesson 2: Why Human Factors?

I. Story Line
   A. Introduction to main characters
      1. Lt. I. M. Eager
      2. Capt. B. Smart

II. Human Factors Engineering
   A. Definition of
   B. Historical Perspective

III. Systems
   A. Man-machine Systems
   B. Components of Man-machine Systems

Lesson 3: Tragic Mistakes and Positive Consequences

I. Historical Perspective
   A. Examples

II. Common Errors - Reading and Interpreting Instruments

III. Common Errors - Operating Controls

IV. Current Status of Human Error

V. Man-Machine Incompatibilities
   A. Man-machine Capability Differences

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[6]Extracted directly from the Student Supplement of the Human Factors Engineering Self-Paced Course.

Lesson 4: Basic Information Processing, or Is Man a Machine?

I. Attention
   A. Limits to
   B. Selective Attention

II. Judgments
   A. Absolute
   B. Relative

III. Man-machine Systems
   A. Man the Processor
   B. Stimulus-Response Codes
   C. Information Transmission
   D. Input-output Processes

Lesson 5: History and Related Technology, or Human Factors, This Is Your Life

I. History - HFE
   A. Ancient Cultures
   B. Industrial Revolution
   C. World War II
   D. Current Efforts

II. Stage of HFE Development

   A. Pretechnology
   B. Aerospace
   C. Sociotechnical
   D. Cosmopolitan

III. Review

Lesson 6: Anthropometry, or Do I Fit?

I. Introduction
   A. Definition
   B. Historical Perspective

II. Design Principles
   A. Adjustability
   B. 5th - 95th Percentile Range

Lesson 7: Work Space Design and Arrangement, or Don't Cramp My Style

I. Work Space Envelope
   A. General Design Principles

II. Analytical Methods
   A. Indexing/Rating Method
   B. Link Analysis
   C. Prototypes

III. Component Location and Spacing Problems

Lesson 8: Vision Capabilities, or A Shot In The Dark!

I. Visual Anatomy-Supplement

II. Visibility

III. Panel Lighting
   A. Flood Lighting
   B. Integral Lighting

IV. Visual Detection, Identification, and Estimation

Lesson 9: Vision Displays, or Are My Eyes Deceiving Me?

I. Types of Displays
   A. Quantitative
   B. Qualitative
   C. Static
   D. Dynamic

II. Scales
   A. Digital
   B. Fixed Pointer
   C. Moving Pointer

III. Signal and Warning Lights
   A. Detection Factors

IV. Alphanumeric and Symbolic Characters

LESSON 10: Auditory Presentations, or When Is An Alarm Not An Alarm?

I. General Types of Displays
   A. Displays Using Auditory Modalities
   B. Nature of the Message

II. Sound Characteristics
   A. dB, Hz.
   B. Frequency, Intensity
   C. Human Reception Capabilities

III. General Display Principles

IV. Presentation Principles

V. Warning and Alarm Systems

LESSON 11: Standardization of Controls, or Which Way Is Up?

I. Standard Arrangement - Population Stereotypes

II. Categorizing Controls
   A. Quantitative, Qualitative, Representational, and Continuous

III. Functions of Controls
   A. Continuous Adjustment Settings
   B. Discrete Settings

IV. Types of Controls
   A. General Types - Linear, Rotary
   B. Specific - Pushbutton, Toggle Switch, Knobs, etc.

V. General Rules for Selection
   A. MIL-STD-1472C and MIL-HDBK-759

LESSON 12: Positioning of Controls, or The Right Place At The R Right Time

I. Accidental Activation of Controls
   A. Prevention Methods

II. Location of Controls and Displays
    A. Priority, grouping association factors
    B. Location and body position
    C. Spacing between controls

LESSON 13: Control Dynamics, or How Hard To Twist The Knob

I. Design Concepts
    A. S-R compatibility
    B. Control-display ratio, a type of compatibility

II. Types of resistance
    A. Static friction
    B. Sliding friction
    C. Elastic resistance
    D. Viscous damping

III. Feedback
    A. Intrinsic
    B. Extrinsic

LESSON 14: Other Senses, or Controls That Have Shaped-Up

I. Review lessons 11-13

II. Touch
    A. Pressure Sensitivity
    B. Pain
    C. Temperature

III. Touch Coding
    A. Shape coding
    B. Class 'A' and 'B' design
    C. Texture coding

LESSON 15: Vibration and Acceleration, or Take It Easy I Have Weak Stomach!

I. Vibration
    A. Definitions
    B. Measurement
    C. Body Parts affected

II. Whole Body Vibrations
    A. Performance effects
    B. Tolerable limits

III. Acceleration
A. Performance effects
C. Protective measures

LESSON 16: Vigilance, or Stay Awake If You Can

I. Vigilance
A. Definition
B. Examples

II. Performance Decrements Due to Vigilance
A. Time Frame
B. Magnitude of decrement
C. Display characteristics

III. Signal Characteristics
A. Noise
B. Signal intensity
C. Rate of signal presentation

IV. Other Factors Affecting Watch-keeping Behavior
A. Environmental conditions, noise
B. Atmospheric temperature
C. Procedural conditions, work/rest schedules

LESSON 17: Temperature Effects, or Baby, It's Cold Outside

I. Reactions to Temperature Change
A. Physiological
B. Adaptation, sensitization and habituation
C. Effective temperature

II. Extreme Cold
A. Physiological and performance effects

LESSON 18: Atmospheric Effects or I Can't Breathe

I. Description of Atmosphere
A. Gases, density, pressure

II. Hypoxia
A. Factors causing
B. Effects - physiological and performance

III. CO_2 and CO
A. Physiological and performance effects
B. Military specificiations

IV. Radiation
   A. Measurement Definitions
   B. Effects of overexposure

V. Prevention
   A. Mask
   B. Clothing

LESSON 19: Noise, or Can You Hear Me?

I. Auditory Anatomy
   A. Structure
   B. How sound travels in the ear
   C. Mechanical and electrical transmission

II. Properties of Auditory Stimuli
   A. Frequency, intensity

III. Communication
   A. Maskers

IV. Physiological Effects
   A. TTS
   B. PTS
   C. Damage risk criteria

V. Protection Against Noise

LESSON 20: Review of Lessons 1-19

LESSON 21: System Acquisition

I. Department of Defense Acquisition Policy
   A. Variation across systems
   B. OMB A-109
   C. DOD 5000.1

II. Phases of Weapons Systems Acquisition Process
   A. Concept exploration
   B. Demonstration and validation
   C. Full-scale development
   D. Production and deployment

III. HFE and the Acquisition Process

LESSON 22: System Analysis, or The Big Picture

I. Purpose of System Analysis
   A. Scheduling
   B. Identifying limiting factors
   C. System performance criteria
   D. Design Options
   E. Evalutation of Systems

II. Stages of System Analysis
   A. Requirements analysis
   B. Function analysis
   C. Task analysis

III. Major Problem Areas
   A. Subsystems' interaction
      1. Sectionalization technique
   B. Criterion determination
   C. Defining human performance effectiveness

LESSON 23: Task Analysis: History and Perspectives

I. Recent History of Task

II. Definition of Task Analysis

III. Other Improtant Task Analysis Factors:
   A. Systems mission and function
   B. Job, task, sub-task, task element
   C. Task inventory, task taxonomy

IV. Output of Task Analysis
   A. Design
   B. Training
   C. Test and evaluation
   D. Manning
   E. Workload

LESSON 24: Task Analysis, or Fitting Task Analysis into the System

I. Stages in Task Analysis Process
   A. Identify task, sub-task, task element
   B. Develop specific behavioral objectives
   C. Identify supporting skills and knowledge

II. Task Statements
   A. Specific behavioral objectives

III. Task Analysis Worksheet

IV. Sampling Techniques
    A. Activity sampling
    B. Process Analysis

LESSON 25: Affordability, or When Can We Trade Off What?

I. Trade-off analysis
    A. Definition
    B. Types:
        1. Geometry of design
        2. Manpower allocation

II. General System Analysis
    A. Operational requirement
    B. Hardware design
    C. Manpower and training requirements
    D. Saftey, reliability,and other factors

III. Four Major Steps in Trade-off Analysis
    A. Baseline Alternative
        1. ROC
        2. Initial Hardware
        3. Manpower and training requirements

IV. Life-cycle Costs
    A. Computer models

LESSON 26: Maintainability, or Can Anybody Fix This?

I. Basic Concepts
    A. Maintainability
    B. Maintenance
    C. Reliability
    D. Human performance

II. Design Features

III. Skill Application
    A. Capabilities/limitations
    B. Training

IV. Predictions

LESSON 27: Hazard Analysis, or A Stitch in Time

I. Introduction
   A. HFE and safety
   B. HPE and safety design

II. Introduction to Hazard Analysis

III. Identification Phase
   A. Checklists
   B. Historical records - intermediate indicators
   C. General Investigations

IV. Evaluation Phase
   A. Grouping according to category
   B. Ranking within category

V. Cost Countermeasures

LESSON 28: Training the Right People

I. Selection and Training in Design/Conceptual Phase
   A. Approaches
      1. Organizational Analysis
      2. Job analysis
      3. Person analysis

II. Training Techniques
   A. On-the-job training
   B. Classroom training
   C. Computer-aided instruction
   D. Team Training

LESSON 29: Does Training Work ?

I. ISD Phases
   A. Analysis
   B. Design
   C. Develop
   D. Implement
   E. Control

II. Validity and Reliability
   A. Types of validity
      1. Training
      2. Performance
      3. Intra-organizational
      4. Inter-organizational

III. Simulator Training Issues

LESSON 30: Psychophysical Methods, or Do I Detect a Signal?

I. Psychophysics
   A. Definition
   B. Purpose

II. Classical Methods
   A. Methods of limits, adjustment and constant stimuli
   B. Assumptions
   C. Advantages, disadvantages

III. Theory of Signal Detection
   A. Response bias
   B. Decision matrix

IV. Scaling Methods
   A. Direct
   B. Indirect

LESSON 31: Experimental Methods, or How Do I Know If I've Done It Right

I. Eager's Experiment

II. Research Categorization
   A. Theoretical
   B. Empirical
      1. Observation, correlation, experimenttation
      2. Natural (field), laboratory

III. Variable Classifications
   A. Qualitative and quantative
   B. Independent and dependent
   C. Relevant
      1. Subject
      2. Situational
      3. Sequence

LESSON 32: Experimental Methods, or How Do I Control These Influences?

I. Control Techniques
   A. Subject
   B. Situational
   C. Sequence

II. Designs
    A. Within subject
    B. Between subjects
        1. Simple randomized
        2. Factorial

III. Validity
    A. Internal
    B. External

Lesson 33: Statistics, Part I

I. Introduction
    A. Description of total statistics lessons
    B. Description of statistics
    C. Purpose of statistics

II. Frequency Distributions

    A. Ungrouped data
    B. Internal data
    C. Meaning of any one score
    D. Percentile ranks

III. Measures of Central Tendency
    A. Mean
    B. Normal curve
    C. Median

IV. Measures of Despersion
    A. Mean deviation
    B. Standard deviation
    C. Variance
    D. Relation of 50 and normal curve

LESSON 34: Statistics, Part II

i. Correlation
    A. Degree
    B. Direction

II. Inferential Statistics
    A. Nonparametric
    B. Parametric
    C. Appropriate statistical tests
        1. t-test
        2. F test
        3. ANOVA

III. Interpretation of Results

A. Practical vs. statistical significance
B. One-way ANOVA
C. Two-way ANOVA
D. Higher order ANOVAs

LESSON 35: Review, or How Have I Done So Far?

LESSON 36: Human Factors and the Military

I. AR 602-1

II. MIL-STD-1472C

III. MIL-HDBK-759

IV. MIL-STD-1474B

LESSON 37: Human Factors Test and Evaluation, or Can a HFTEMAN Cross a MOAT using a HEDGE?

I. HF Testing
A. HEL TM 29-76
B. MOAT
C. HFTEMAN
D. HEDGE
E. HRTES

II. Human Performance Measures
A. Analysis of human performance data

LESSON 38: Real World Problem, Part I

LESSON 39: Real World Problem, Part II

LESSON 40: Overall Summary

APPENDIX E

EVALUATION PLAN FOR THE HUMAN FACTORS ENGINEERING SELF-PACED COURSE

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Annex F - Student Attitude Questionnaire

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Acronyms and Abbreviations

COTF	Commander Operational Test and Evaluation Force
CCS	Command Course Supervisor
DCOTF	Deputy Commander Operational Test and Evaluation Force
HF	Human Factors
HFE	Human Factors Engineering
HFTEMAN	Human Factors Test and Evaluation Manual
NPS	Naval Postgraduate School
PMTC	Pacific Missile Test Center
SIF	Student Information Form

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(b) Human Factors Test and Evaluation Manual (HFTEMAN), Vols. I, II, and III, Octover 1976, Pacific Missile Test Center

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(i) Interservice Procedures for Instructional Systems Development, Executive Summary and Model, 1 August 1975, NAVEDTRA 106A

(j) COMOPTEVFORINST 3960.1B 5 July 1979

(k) Procedures for Instructional Systems Development, 12 July 1978, NAVEDTRA 110

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[7]Several of the references used to design the test plan have been revised and incorporated into the main body of the thesis. The criteria and standards are in accordance with the updated versions of the above instructions.

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Section I

Introduction to the Evaluation Plan

101. Purpose. The purpose of this evaluation plan is to assess the operational effectiveness of the Human Factors Engineering (HFE) Self-Paced Course and its potential value for use in the military test and evaluation community.

102. Course Description. This course is divided into three major sections, Section I (Lessons 1-5) deals with the human's capabilities and limitations. In this section, the history and continued need for human factors engineering will be investigated. Lessons 6-10 are concerned with the physiological capabilities and limitations of human beings. Lessons 11-13 discuss how the proper design of controls and displays makes use of the information learned in the previous lessons. Lessons 14-19 take a look at human interactions with the environment, followed by a review of the first section in lesson 20.

The primary focus of Section II is upon the human fitting into the system. Lessons 21-27, investigate the role of the human engineer in various aspects of analysis, such as systems analysis, cost analysis, task analysis, etc. Lessons 28-29 are concerned with the selection and training of personnel. In lessons 30-34, the student will receive a short course on experimental techniques and statistical concepts. Finally, lesson 35, will offer a review of Section II.

Section III is entitled "Human Factors in the Military". In this section, lessons 36 and 37 focus on human factors organizations, documentation, and future application.

In order to give the students a practical application of what has been presented in the course, lessons 38 and 39 will ask him/her to work on a "real world" problem. Finally, in lesson 40, a more typical review of the entire course is presented.

103. Background. The HFE Self-Paced Course was developed to satisfy a need for increased awareness and more indepth understanding of Human Factors.

Reference (a), highlights this need and identifies a deficiency in the performance of various weapons systems "...because the DOD does not pay enough attention to logistic support, human factors and quality assurance during the design phase of the acquisition process. These problems deter the systems' effectiveness to defend our country in case of war." The Government Account Office (GAO) "therefore makes recommendations to improve the management and planning of ownership considerations that have an impact on the effectiveness of a weapon system."

The Human Factors Test and Evaluation Manual (HFTEMAN), Vols. I, II and III (reference (d)) was distributed to various government agencies in October 1976 by Pacific Missile Test Center, Pt. Mugu, California. HFTEMAN was developed to provide

standardization in procedures, testing and criteria in evaluating human factors. It, however, assumes a basic knowledge of human factors for its most effective use.

The HFE Self-Instruction course was developed in order to provide this basic knowledge. It has not been evaluated or used on a trial basis in any portion of the military prior to this time.

Section II

Administrative Information

201. General. General responsibilities for activities involved in this evaluation are provided in this section, as well as appropriate points of contact. Continuing close liaison is essential to timely and successful prosecution of this evaluation.

202. Responsibilities.

a. Naval Postgraduate School (Lt. M. M. Fleming)

(1) Promulgate major changes to this evaluation plan.

(2) Coordinate arrangements for HFE course subjects.

(3) Coordinate distribution of required course materials to participants.

(4) Conduct briefings for all participating if so requested and funded by the requesting activity.

(5) Provide certificates of completion or equivalent.

(6) Analyze evaluation results and make them available to the appropriate units upon request.

b. COMOPTEVFOR, DEPCOMOPTEVFOR, AFT&E Center/TELH, TESTG/ENAH

(1) Furnish names and/or Student Information Form (SIF) numbers of participating students.

(2) Provide point of contact for test subjects within each command (Command Course Supervisor - CCS).

(3) Keep Lt. M. Fleming advised of students progress.

c. U. S. Army Human Engineering Laboratory, Pacific Missile Test Center (PMTC):

(1) Provide required number of copies of all course materials for distribution to subject students.

(2) Provide point of contact to Lt. Fleming.

(3) Provide required plans, schedules and procedural guidelines as indicated in Section IV.

203. Points of Contact.

a. Naval Postgraduate School

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Section III

Scope of the Evaluation

301. Objectives. In accordance with the recommendations of reference (a), standardized objectives upon which this course is to be evaluated will follow the procedures found in references (c) through (j) and as follows:

a. Course Objectives. The course objectives must be developed according to accepted standardized structure in order to prepare the student to perform his/her job in testing and evaluating human factors.

b. Course Material Design. The format of the course materials must aide the student in accomplishment of the stated learning objectives. The following areas are included in this evaluation:

1. Sequence and structure
2. Figures and Tables
3. Symbology and legends
4. Layout and format

c. Course Content. The course content must support the course learning objectives.

d. Course Presentation. The design of the course presentation aids the student in accomplishment of the course learning objectives without the aid of an on-site instructor.

In addition to the above, future plans for the following will be reported:

a. Course Availablility. The course materials should be maintained in sufficient quantity to meet the needs of those it will serve.

b. Course Maintainability. The course materials must be in accordance with the most recent version of the references upon which it is based and human factors design developments.

c. Course Supportability. Assistance must be available by correspondence with the issuing agency. Feedback must be provided to the student on his/her performance. The life cycle cost of the course must be available for future planning and assessment.

302. Criteria. The criteria below are in accordance with references (e) through (i) and other resource materials listed in the bibliography.

a. Course Objectives. The course learning objectives should have all the characteristics listed below.

1. Objectives must be a statement of student behavior (action), such as the creation of a product or some other overt act, which can be accepted as evidence that the intended outcome has occurred.

2. The behavior must describe specifically all outcomes that will demonstrate that learning has occurred.

3. The student behavior called for must be capable of observation and evaluation within the learning and testing environments.

4. The objective must be stated in learner rather than teacher terms, i.e., actions which the student will perform rather than what the instructional materials will "say or do".

5. There must be a standard against which the student

behavior will be measured. It must be fully specified.

6. The statement of the conditions under which the student behavior will occur must be fully specified.

Additionally, students must be able to satisfy the objectives during the normal performance of their jobs in human factors test and evaluation.

b. Course Material Design.

1. Sequence and structure. The learning objectives should be arranged in the sequence in which instruction will be presented to the student.

2. Figures and Tables. Sufficient information should be provided with each figure and table to allow the student to apply it as directed within the sourse materials and during performance of his/her job when left only with the student supplement.

3. Symbology and Legends. The symbols and legends presented in the course materials should be implicit and standardized where possible.

4. Layout and format. The layout and format must aide the student in accomplishment of course objectives and encourage motivation and desire to complete the course.

c. Course Content. The mean score of the course groups' second diagnostic tests must be at least one standard deviation above the mean score of the control groups' second diagnostic test.

d. Course Presentation. The instructions and verbal context of the course materials must allow accomplishment of course objectives and course completion without the aide of an on-site instructor.

303. Evaluation.

a. Site selection. The evaluation of the HFE course will be conducted at various evaluation sites which are involved in test and evaluation of systems involved in the acquisition cycle. Testing at these sites will provide a realistic environment in which to exercise the course. The course is designed for personnel with this same job type and responsibilities.

b. Personnel selection. Subjects participating in this evaluation will be drawn from three military commands whose primary mission is operational test and evaluation. Some personnel will be volunteers, while others may be assigned to participate.

1. Specialty area. It is anticipated that the evaluation subjects will be drawn from the various divisions within each command (air, surface, subsurface and special warfare).

2. Special requirements. No constraints regarding rate, rank, AFS, grade, educational level or prior experience will be placed on participants. The only requirement is that each subject be actively involved in planning and performing operational test and evaluation.

c. Data Collection. Data sheets, course diagnostic tests and questionnaires for use in this evaluation are contained in Annex A. Copies will be distributed to Command Course Supervisors prior to beginning the evaluation. More specifics regarding the actual evaluation procedures are provided in Section IV.

304. Limitations to Scope. While the HFE Self-Instruction Course consists of 40 lessons, only the first 20 are scheduled to be evaluated. All activities taking part will be provided with all 40 lessons in order to provide subjects the opportunity to complete the course at a pace faster than that recommended by Pacific Missile Test Center.

The criteria established for assessing the adequacy of the course objectives require a prolonged period for a full and complete evaluation. This evaluation lasts only for a period of 30 days and will only analyze the completed questionnaires of the participating subjects. This will only provide a preliminary and limited assessment. Therefore, it is recommended that a second questionnaire be drafted and distributed to the course participants six months after course completion. The subjects then will have had an opportunity to apply what the course taught them and make a more accurate assessment of of its value.

Section IV

Evaluation Guideline

401. Evaluation participants and HFE Course Materials. The HFE course is designed to provide Human Factors training to personnel responsible for planning and conducting testing in human factors. This is part of the job of an Operational Test Director (OTD) as stated in references (c) and (j). The personnel aiding in the evaluation of this course should therefore have the same responsibilities. This is the reason for the selection of the particular evaluation sites. This course was designed for the job and is not limited as to rate, rank, Air Force Specialty (AFS), grade, educational level or prior experience of the participant.

402. Evaluation Procedures. The HFE course will be conducted as follows:

a. Student Information Forms (SIF's) must be filled out by the CCS for each course participant (See Annex A). At that time, each student will be assigned a 4-digit code. The first two digits (from the left) identify each individual command:

COMOPTEVFOR	01XX
DEPCOMOPTEVFOR	02XX
AFT&E Center	03XX
TESTG/ENAH	04XX

The last two digits are then assigned in numerical sequence to each participating student:

Student 1	XX01
Student 2	XX02

Example: COMOPTEVFOR -- 3 students

Student 1	0101
Student 2	0102
Student 3	0103

This HFE SIF course number should be retained by both student and supervisor. It should appear on all correspondence, tests, questionnaires and SIF's of each student.

b. After an SIF has been completed and prior to beginning the course, each student will be given a diagnostic test, to determine the individual level of each student before beginning the course. Each CCS will administer the test and make the purpose of the test clear to each participant.

In addition, the student must be instructed not to guess if an answer to a particular question is not known -- the answer should be left blank. The tests will be mailed back to NPS immediately upon completion for retention and evaluation.

c. Following the diagnostic test, each student will be provided with the course materials and references. A schedule for timely completion of the course will also be provided. Upon completion of the course, a final diagnostic test will be administered to each student, by the CCS. This test is also designed around the course objectives. While the questions are not the same as the first diagnostic test, they will basically cover the same material. This test is to be mailed back to NPS for scoring. The performance of the student on each of the diagnostic tests will then be compared. Should the participant wish to

to know his/her score on the test(s), it/they will be provided by the Evaluation Director at NPS upon request.

d. A questionnaire will be provided to each student who begins the course to provide feedback on individual opinions about the course after each has completed it.

e. A questionnaire will also be provided to each CCS.

f. Questions asked by the student should be recorded by the CCS in the provided log. Each question should also be identified with an SIF number.

403. Test 01. Course Objectives.

a. Object. To assess the extent to which the course objectives support the tasks required of a human factors test and evaluation agent.

b. Procedure. A task analysis of the human factors specialist will be compared to the course objectives. Questionnaires regarding the course objectives will be distributed to various resources dealing with human factors test and evaluation and curriculum design.

c. Data Requirements. A task analysis of a human factors test and evaluation specialist and completed questionnaires are required.

d. Data Analysis. Course objectives will be compared to the task analysis to evaluate how adequately the course objectives support the person responsible for performing human factors test and evaluation.

404. Test 02. Course Materials Format.

a. Object. To assess readibility, standardization and clarity of format according to references (e) through (i).

b. Procedure. Questions directed to the CCS by each participant relative to the HFE course for clarification or explanation will be recorded. Questionnaires will be provided to students and CCSs upon course completion and/or end of test period, which ever applies.

c. Data Requirements. All recorded student questions, questionnaires and comment sheets will be forwarded to the

to the Evaluation Director at NPS, upon completion or end of test period which ever is applicable.

d. Data Analysis. Questionnaire responses will be evaluated and the results tabulated. (See Annex B for further details.)

405. Test 03. Course Content.

a. Object. To assess the extent to which the course content supports the course objectives.

b. Procedure. Two diagnostic tests will be administered to each student; one prior to beginning the course and one following its completion. A questionnaire will also be provided at course completion. The SIF number will be placed on each.

c. Data Requirements. Participant test answer sheets and completed questionnaires must be returned to the evaluation director at NPS as they are turned in to each supervisor.

d. Data Analysis. A mean and its standard deviation will be computed for each of the diagnostic test scores. The mean scores will then be compared. The individual responses to test questions will also be compared.

Both diagnostic tests will also be administered to a control group. These individuals will not be taking the course. The purpose will be to substantiate the reliability of the tests, and to assess whether the scores of the course participants change more than do scores of the control group.

Individual questionnaires will also be evaluated and analyzed. (See Annex B for further details).

406. Test 04. Course Presentation.

a. Object. To assess the clarity of the presentation of course content, in order to allow the student to complete the course without the aid of an on-site instructor.

b. Procedure. See Test 02.

c. Data Requirements. See Test 02.

d. Data Analysis. See Test 02.

407. Test 05. Course Availability.

a. Object. To report on the plans for making course materials available to future students. (Implementation and Control).

b. Procedure. Review the plans PMTC would recommend for making course materials available for general use.

c. Data Requirements. Provision of the implementation and controls plans from the issuing agency will be required.

d. Data Analysis. The response of the issuing agency will be reported. No other analysis is intended.

408. Test 06. Course Maintainability.

a. Object. To report on the plans for keeping the instruction manuals up to date with the applicable military standards it references and latest human factors developments and procedures.

b. Procedure. Review the plans of the issuing agency

for scheduling updates in order to keep the course content current.

c. Data Requirements. Provision of the course maintenance plans will be required of the issuing agency.

d. Data Analysis. The response of the issuing agency will be reported. No other analysis is intended.

409. Test 07. Course Supportability.

a. Object. To assess the plans and procedures for providing adequate support to students taking the HFE Self-Paced Course.

b. Procedure. Review the plans and procedures provided by the issuing agency for supplying the support required by the student for successful completion of the course.

c. Data Requirements. The issuing agency will provide the required documents to the NPS Evaluation Director for review.

d. Data Analysis. See Test 06.

Section 5

Report(s)

501. General. The results of this HFE Self-Paced Course Evaluation will be provided in the Evaluation Director's thesis.

ANNEX B

CCS LOG FORMAT

INTRODUCTION

FOR

COMMAND COURSE SUPERVISOR (CCS)

You have been identified by your command to be my point of contact with your command in the evaluation of the Human Factors Engineering Self-Instruction Course during the period 1 September - 31 October 1981. The actual length of the evaluation at your command may vary depending on how quickly the individual student participants complete the course.

In reading the CCS Guidelines, you will find that your responsibilities, very basically, consist of:

(1) Filling our Student Information Forms (SIF)

a. Assigning SIF identification numbers.

(2) Distributing and collecting diagnostic tests/ questionnaires, comments and course materials.

(3) Maintaining your CCS log

a. Student Progress Record

b. Student Question and Comment Record

c. Student Questionnaires

d. CCS Questionnaires

e. Evaluation Completion Checklist

(4) Contacting me for the answers to any questions which the student participant may ask that are not obvious to you or have not been provided in the material sent you. My phone number is: Autovon: 878-2536

(5) Returning all materials and correspondence as each is completed; but no later than 1 November 1981.

Mail to:

Lt. Martha M. Fleming
Naval Postgraduate School
SMC # 1340
Monterey, Cal. 93940

EVALUATION GUIDELINES

FOR THE

COMMAND COURSE SUPERVISOR (CCS)

1. Student Information Forms (SIF) and Diagnostic Test #1:
It is recommended that you arrange to meet with participants in a group.

a. Before the meeting, it is essential that you:

(1) Read the SIF Instruction sheet to be sure that you understand what is wanted in each question.

(2) Fill in the SIF numbers on each form.

b. During the meeting:

(1) Explain what the evaluation is all about. Hand out EO-1/4.

(2) Hand out the "Privacy Act Statement" (DA Form 4368-R, 1 May 1975), which is attached to the front of the SIF. This form basically promises them confidentiality of the information they provide in the SIF and the questionnaires. As long as they follow directions provided, only the participant and the Evaluation Director at the Naval Postgraduate School will see their responses to questionnaires and test results. As it states at the bottom of the form, they may keep DA Form 4368-R, but do need to return the attached SIF.

(3) SIF: Point out that "name" is optional. The rest should be self-explanatory. If not, you have the SIF Instruction Sheet which should provide you with any necessary clarifying information.

(4) Diagnostic Test Number 1: After the SIF has been collected:

(a) Pass out the "Diagnostic Test Number 1".

(b) Read through the instructions with the students orally. Be sure to highlight those statements or words which are underlined.

(c) Offer them the opportunity to take the test in a room where it is nice and quiet; where they won't be disturbed. They may take the test back to their desks or spaces, which ever they would feel most comfortable doing. Even though the test is designed to see how much they know about the world of human factors before taking the course, the test is not going to be graded, per se, as there is no standard against which to measure. The students are ON THEIR HONOR to do the test by themselves without reference material or other help. The test must be turned in by the end of the working day.

(d) Should some choose to take the test then and there, position yourself in the room so that you are available to <u>answer and record questions</u> the participants ask of you. Do NOT walk up and down the aisles. This is in an effort to relax the tensions many people have when they sit down to take any kind of a test.

(e) Remember, there is <u>no time limit</u>, so allow yourself adequate time for proctoring the test. For planning purposes, the test is designed so that even with no

previous background in human factors, the test should be easily completed within 45 minutes. Students, however, are not required to complete the test within this time period.

2. Command Course Supervisor Log: The CCS Log consists of the following:

SIFs for all participants

Student Progress Records

Student/CCS Questions and Comments Record

Unanswered Student Questionnaires

CCS Questionnaire

Evaluation Completion Checklist

FOR FURTHER CLARIFICATION:

a. SIF: Keep these in the appropraiate section of your log. Dividers have been provided. See also the "SIF Instruction" sheet.

b. Student Progress Records: Record the completion date for:

(1) SIFs

(2) Diagnostic (D-Test) Test #1

(3) Each lesson book

(4) Diagnostic Test #2

(5) Student Questionnaire

(6) CCS Questionnaire

Be sure to keep track of the proper SIF number for each student.

c. Student Questions and Comments Record: Each time either you or a student have a question or comment, record

the following:

(1) date.

(2) SIF number.

(3) the question or comment.

(4) the answer provided.

d. Student Questionnaires: Blank questionnaires have been provided so that they are available as each student completes the second diagnostic test. These may be taken away for completion.

EVALUATION OUTLINE

I. Purpose of the Evaluation: The purpose of this evaluation is to assess the operational effectiveness of the Human Factors Engineering (HFE) Self-Instruction Course and its potential value for use in the Fleet test and evaluation community.

II. Course Description: This course is divided into three major sections, Section I (lessons 1-5) deals with the human's capabilities and limitations. In this section, the history and continued need for human factors engineering will be investigated. Lessons 6-10 are concerned with the physiological capabilities and limitations of human beings. Lessons 11-13 discuss how the proper design of controls and displays makes use of the information learned in the previous lessons. Lessons 14-19 take a look at the human being as he/she interacts with his/her environment, followed by a review of the first section in lesson 20.

The primary focus of Section II is upon the human as he/she fits into the system. Lessons 21-27, investigate the role of the human engineer in various aspects of analysis, such as systems analysis, cost analysis, task analysis, etc. Lessons 28-29 are concerned with the selection and training of personnel. In lessons 30-34, the student will receive a short course on experimental techniques and statistical concepts. Finally, lesson 35, will offer a review of Section II.

Section III is entitled "Human Factors in the Military". In this section, lessons 36 and 37 focus on human factors organizations, documentation, and future application.

In order to give the students a practical application of what has been presented in the course, lessons 38 and 39 will ask him/her to work on a 'real world' problem. Finally, in lesson 40, a more typical review of the entire course is presented.

III. Purpose of the HFE Course: The HFE Self-Instruction Course was developed to satisfy a need for increased awareness and more indepth understanding of Human Factors.

The Comptroller General, in his report to the Congress of the U. S., dated January 29, 1981, (PSAD-81-17), entitled Effectivenss of U. S. Forces Can Be Increased Through Improved Weapon System Design, highlights this need and identifies a deficiency in the performance of various weapons systems "because the Department of Defense does not pay enough attention to logistic support, human factors and quality assurance during the design phase of the acquisition process. These problems deter the system's effectivenss to defend our country in case of war.

GAO therefore makes recommendations to improve the management and planning of ownership considerations that have an impact on the effectiveness of a weapon system."

The HFE Self-Instruction course was developed in order to provide a basic knowledge of human factors and how to test for its effectiveness. The course has not been evaluated or used on a trial basis in any portion of the Navy prior to this time.

IV. Summary of Evaluation Steps: It is anticipated that each of the 40 lessons will require on hour completion time. While the course developers recommends 40 working days to complete the entire course, time constraints levied necessitate completion prior to 31 October 1981.

(1) Introduction by Command Course Supervisor (CCS)

(2) Receive Privacy Act Statement

(3) Fill out Student Information Form (SIF)

(4) Receive instructions for and take Diagnostic Test #1

a. student supplement

b. lesson booklet 1-5

c. applicable references

(6) Return each lesson booklet as it is completed and pick up the next one in the series, until all 40 lessons are completed.

(7) Receive and take diagnostic test number 2

a. return test in sealed envelope

(8) Fill out student questionnaire

a. Indicate whether or not test results are desired

b. Be sure SIF number is visible on envelope

c. Return questionnaire to CCS in sealed envelope within two working days or not later than 31 October 1981, which is soonest.

Should you experience any repeated difficulty or delays in locating your CCS, feel free to contact me. I do not have my own phone, however, a secretary will take the message and I will get back to you. Please remember that there is a three hour

time difference between the East and West Coasts. Your 1345 is our 1645 and the secretaries leave at 1630.

Lt. Martha M. Fleming
Naval Postgraduate School
SMC #1340
Monterey, California 93940

Autovon: 878-2536
Commercial: 408-646-2536

DIAGNOSTIC TESTS INSTRUCTIONS

Purpose: The purpose of the first diagnostic test is simply to see how much you know about human factors before you begin the Human Factors Engineering (HFE) Self-Instruction Course. This is why we call it a diagnostic test. After you have completed the HFE course, a second diagnostic test will be given. The purpose of this test is to see how successfully the HFE course has increased your awareness of the various facets of human factors.

Guidelines: In order to perform an accurate comparison analysis of the two tests, there are several things which we must ask of you while taking these diagnostic tests:

(1) Answer the questions to the best of your knowledge, do not get anyone to help you or explain the question to you. On the first diagnostic test, you are not expected to know the answers. We hope that the HFE course will help you answer the questions on the second test.

(2) Do not guess ! Please, if you understand the question, but do not know the answer, select the option which indicates that you don't know. We realize that this is against your human nature and therefore is difficult to do, but we ask that you try.

(3) This is an evaluation of the HFE Course, not of the course participants. You do not flunk or pass; the course does. If it is so indicated by your tests, questions, comments and questionnaires, the course will return to Pacific Missile Test Center for rework. Therefore everything you have to say about

the course will help us make sure it will be a good one when it "hits the streets".

(4) If a question does not make sense and needs clarification, see your Command Course Supervisor (CCS).

(5) Your CCS will be recording your questions as you ask them. If you have a question, then obviously the materials didn't make it clear enough and need to be changed. You can help your CCS by writing your question down -- don't forget to put your SIF identification number on it.

(6) Since the HFE course is designed to fit the needs of the job of testing and evaluating human factors, rate, rank, grade or educational level should not make a difference. Again, if it does, the course materials need to be improved.

(7) Where you take the test is up to you. Your CCS will provide you time and a place to take the test, giving you easy access to him/her for questions and a place where you will not be disturbed. You may elect to take the test back to your desk or office, however, remember not only the HONOR SYSTEM of paragraph number one, but also that the test must be returned to the CCS in a sealed envelope by the end of that working day.

(8) Should circumstances beyond your control prevent you from finishing the course materials, you still must:

a. Notify your CCS

b. Take diagnostic test #2

c. Fill out the student questionnaire

Since each test is progressively designed you will still provide valuable data by doing (b) and (c) above.

(9) Do you want to know your test results? You may make that choice while answering the student questionnaire. Your CCS will not have the results as the tests are analyzed by the Evaluation Director at the Naval Postgraduate School. They will be forwarded to you at the end of the evaluation upon receipt of your request.

(10) Do you have any questions? If so address them to your CCS now.

In Summary:

(1) Do the best you can.

(2) Do not guess.

(3) The course is evaluated, not the participant.

(4) Questions and comments will be recorded in logs maintained by your command's Course Supervisor.

(5) Rate, rank, grade, AFS, educational level and prior experience should not make a difference.

(6) Take your Diagnostic Test #1 where you want, but turn it in by the end of that working day.

(7) Once you start the course, plan on taking diagnostic test #2 and filling out the student questionnaire. Return the test by the end of that working day and the questionnaire within two working days.

(8) Want your test results? Tell us so in the questionnaire.

(9) Questions? Ask the CCS.

**THANK YOU for participating in this evaluation; without you it wouldn't be happening.

COMMAND COURSE SUPERVISOR (CCS)

EVALUATION COMPLETION

CHECKLIST

1. Administrative Wrap-Up

a. Be sure that each of the following has been completed:

(1) SIF identification numbers on all completed items.

(2) SIF for each participant.

(3) Student Progress Records.

(4) Student/CCS Question & Comment Record.

(5) Diagnostic Tests #1 and #2 from EACH PARTICIPANT beginning the Human Factors Engineering Self-Instruction Course.

(6) Student Questionnaire from EACH PARTICIPANT beginning the course.

b. Retain some way to identify students with their SIF identification numbers. This will be necessary should any participants request their test scores or evaluation results. We do not wish to know them, only that you be able to pass on the information upon its receipt.

2. Return the following together in one package by AIR MAIL -- FIRST CLASS -- NO LATER THAN 1 NOVEMBER 1981:

a. CCS Logs and all completed copies of:

(1) Student Information Forms (SIF)

(2) Diagnostic Test #1

(3) Student Progress Record

(4) Student/CCS Question and Comment Record

(5) Diagnostic Test #2

(6) Student Questionnaires

(7) CCS Questionnaire

3. Return the following together in a separate package by PARCEL POST--Bookrate:

a. All course materials and extra, uncompleted forms and questionnaires:

(1) Student Supplement

(2) Booklets for lessons 1-40

(3) Course references (MIL-STDs and TECHMEMOs)

(4) SIFs

(5) Diagnostic Tests 1 and 2

(6) Student Progress Records

(7) Student/CCS Question and Comment Records

(8) Student Questionnaires

(9) CCS Questionnaires

STUDENT PROGRESS RECORD

Student SIF #	SIF	Ques-tion-naire	#1 D-Test	#2 D-Test	Completion Date (month & day)							
					1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40
CCS												

STUDENT QUESTION & COMMENT RECORD

DATE	SIF #	Student's Question/Comment

ANNEX C

DIAGNOSTIC PRETEST

DIAGNOSTIC PRETEST INSTRUCTIONS

PURPOSE. The purpose of this test is merely to identify the level of your familiarity with human factors engineering BEFORE you take the self-paced course. A second diagnostic test will be given after lesson 20. If the course fulfills its purpose, the level of your human factors engineering familiarity should increase. The results of the second test should support this theory.

FORMAT. This prediagnostic test has eight pages and 28 questions. If the test is designed correctly, it should require less than one hour to complete.

DESIGN. There are several different types of questions:

1. Multiple Choice - These questions are identified by such terms as "CHOOSE" or "SELECT". One or more answers may be correct. Identify your choice by placing an "X" in the space provided.

2. Matching _ The word "MATCH" denotes such questions. Only one answer should be chosen for each term on the left. Some of the phrases or acronyms on the right may be left unused; don't worry, the question was designed that way.

3. Fill in the Blank - Words such as "NAME", "IS CALLED" or "LABEL" identify these types of questions. Sentences requiring completion are also examples of "fill ins". You should not need to use more than 5 words to answer those questions.

4. Short Answer - These questions are identified by such terms as "EXPLAIN", "DESCRIBE", "DEFINE", "WHY", "WHAT, and/or ask for examples.

Be brief and to the point, but remember, that someone else must be able to understand your answer; so work on its clarity.

5. Application - One question asks you to redesign, if necessary, a display mechanism. Should you decide it is needed, DRAW the redesigned mechanism in the space provided. Remember, however, you may be happy with the displays as they are presented. Should that be the case, do nothing.

TEST VALIDITY. It is essential that you do this test by yourself, without the use of references or outside resources. To do so will affect the validity of the analysis method selected for this evaluation.

GUESSING. If you want to guess, go ahead. You would anyway, even if I told you not to do so.

GRADING. Keep in mind that the test is being graded, not you. Should you like to know the score the test made, you will have the opportunity to let us know at the end of the evaluation period.

DIAGNOSTIC PRETEST

MULTIPLE CHOICE: Choose the best answer(s). One or more than one answer may be correct. Place an 'X' by your choice(s).

A. The overall objective in taking a human factors engineering course is:

_____1. to obtain the human factors engineering background necessary to do your job well.

_____2. to understand a person's specific capabilities and limitations.

_____3. to understand the precise military procedures involved in a human factors program.

_____4. to understand the importance of applying the concepts and priorities of human factors engineering in your job.

B. The main reason for poor system performance is human error which is caused by:

_____1. inadequate consideration of human performance capabilities, skill limitations and response tendencies.

_____2. little standardization of 'controls'. (knobs, levers, etc.).

_____3. the fast developing pace of new technologies with which the human's capabilities cannot keep up.

_____4. people with too little education and too few skills being brought into the armed services.

_____5. inadequate human factors input into system man-machine interface.

C. There are three main areas of the human's information processing capabilities. MATCH the terms on the left with the appropriate example(s) on the right.

_____1. selective attention

_____2. physiological processing limitations

_____3. channel capacities

a. hear a signal above 20,000 CPS

b. interrupting normal procedures to react to an alarm bell.

c. listening to four incoming ship to ship and two secure voice radio messages simultaneously on the bridge of a ship

d. breaking out in a cold sweat when required to perform a specific duty.

D. MATCH the sensory modalities with the related stimulus dimensions:

_____1. vision	1. saltiness
_____2. audition	2. hue
_____3. odor	3. pure tones
_____4. taste	4. smell

E. EXPLAIN WHY each of the following areas is important in human factors design evaluation:

1. information processing capabilities:_____

_____

_____

2. sensory modalities:_____

_____

_____

F. The science dealing with measurement of the physical features and functions of the body is called_____.

G. The term which refers to the measurement of human body dimensions in a fixed position is _____.

H. NAME the term which indicates that body dimensions are determined from body positions which occur with movement. _____

I. EXPLAIN WHY body dimensions are an important human factors consideration.

_____

_____

_____

J. LIST TWO examples which support your definition on the importance of body dimensions as a human factors consideration:

1. _____

_____

_____

2. _____

_____

_____

K. NAME five environmental considerations which may affect a human's performance:

1. _____
2. _____
3. _____
4. _____
5. _____

L. CHOOSE which phrase deals with the principle of anthropometric design:

_____1. use of population stereotype

_____2. sequence of use analysis

_____3. 5th - 95th percentile humans

_____4. design for the extreme individual

M. CHOOSE which phrase deals with the principle concerned with the general design layout.

_____1. sequence of use

_____2. length of use

_____3. vigilance capabilities of the operator

_____4. frequency of use

_____5. function of a component

N. NAME FOUR methods of gathering human factors data on human activities:

1. _____

2. _____

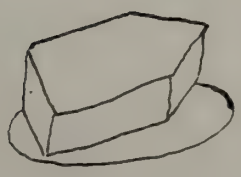
3. _____

4. _____

O. What is the purpose of link analysis? GIVE AN EXAMPLE.

P. Knobs should have basic standardized functions. MATCH the terms on the right with the figures on the left.

Column (1)	Column (2)
_____	_____ 1.
_____	_____ 2.
_____	_____ 3.
_____	_____ 4



Column (1):

a. fractional reaction

b. discrete reaction

c. multiple reaction

Column (2):

d. less than 1 full turn and position is not very important

e. less than 1 full turn where position is important

f. at least 1 full turn

Q. CHOOSE which of the combined effects of temperature and humidity the human body will adapt to most quickly:

_____1. extreme heat and high humidity

_____2. extreme cold and high humidity

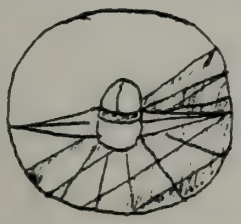
_____3. extreme heat and low humidity

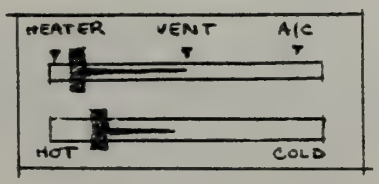
_____4. extreme cold and low humidity

R. LABEL the following display mechanisms as:

(1) quantitative OR qualitative AND

(2) static OR dynamic





a. aircraft 'turn and bank indicator'

(1) _____

(2) _____

b. automobile temperature control

(1) _____

(2) _____

c. submarine depth gauge

(1) _____

(2) _____

S. If you would improve the designs presented in the figures above, SHOW what the recommended design change would look like in the space provided below:

T. DEFINE the term noise: _____

_____

_____

U. There are eight concepts for evaluating control design. Control coding is one of these. NAME FOUR of the six factors which are used when evaluating control coding:

1. _____
2. _____
3. _____
4. _____

V. Another of the eight concepts for control design deals with direction of control movement. Briefly EXPLAIN WHY this is important:

_____

_____

_____

_____

W. When do the greatest performance decrements occur during a watch-standing duty? CHOOSE the best answer(s):

_____1. first 30 - 60 minutes of the watch

_____2. last 30 - 60 minutes of the watch

_____3. last 30 - 60 minutes before lunch break

_____4. workspace temperature is between $75^{o}F$ - $82^{o}F$

_____5. several short rest periods are given between watches

X. What is a task analysis? EXPLAIN: _____

_____

_____

Y. Why is a task analysis so very important in the field of human factors design and evaluation?

_____

_____

_____

_____

Z. MATCH the acronyms with the associated terms:

_____1. radiation	a. PPM
_____2. frequency	b. PSI
_____3. atmospheric contamination	c. RAD
_____4. pressure	d. CPS/Hz
_____5. intensity	e. CLO
_____6. hearing loss	f. dB/PNDB
_____7. insulation	g. PTS/TTS

AA. NAME TWO key military standards (MIL STDS), handbooks or U. S. Army Human Engineering Laboratory Technical Memorandums which provide guidelines and/or criteria for:

1. control design _____ _____
2. environmental factors/ considerations _____ _____
3. anthropometric data _____ _____

BB. NAME ONE key military standard (MIL STD), handbook or U. S. Army Human Engineering Laboratory Technical Memorandum which provides guidelines and/or criteria for:

1. display design _____
2. aural non-detectability _____
3. noise limit selection _____
4. control color coding _____

5. vigilance _____

6. criticism regarding stated criteria governing human exposure to carbon monoxide (CO) _____

You have now completed your first diagnostic test. Don't feel badly if you think that you didn't know many of the answers. You weren't expected to, remember? This test has been a brief introduction as to what you can expect to learn as you proceed through the HUMAN FACTORS ENGINEERING SELF-INSTRUCTION COURSE. The first lesson booklet and the student supplement will be handed to you when you turn this test in to your COMMAND COURSE SUPERVISOR.

GOOD LUCK !!!!!! Hope you enjoy the course and THANK YOU for your participation and support.

ANNEX D

DIAGNOSTIC POST TEST

DIAGNOSTIC POST TEST
INSTRUCTIONS

PURPOSE. The purpose of this test is to measure your familiarity with human factors. Some of you will be taking this AFTER completing the Human Factors Engineering Self-Paced Course Others of you in the "control group" will be taking this test without taking the course. Those of you in the "control group" will be providing a baseline from which to measure the "course group's" test results.

FORMAT. This diagnostic post test has 7 pages and 29 questions. If the test is designed correctly, it should require approximately one hour to complete.

DESIGN. Eventually this course will prepare you to develop a general human factors evaluation outline. This requires a thorough familiarity with the following areas of human factors design and evaluation:

Test objectives	Terms
Criteria	Definitions
Analytical methods	Design principles and concepts
Resource documents	

The content of this test will establish your readiness for course completion.

There are several different types of questions:

1. Multiple choice. These questions are identified by the term "CHOOSE". None, one or more answers may be correct. Identify your choice by placing an 'X' in the space provided.

2. Fill-in-the-blank. Words such as "NAME", "LABEL" or "LIST" identify these types of questions. You should not need to use more than five words to answer these questions.

3. Short answer. The questions are identified by such terms as "EXPLAIN", "DESCRIBE", "DEFINE", "WHY", "WHAT" and/or ask for examples. Be brief and to the point, but remember, that someone else must be able to understand your answer; so work on its clarity.

4. Application. One question asks you to redesign, if necessary, a display mechanism. Should you decide it is needed, DRAW the redesigned mechanism in the space provided. Remember, however, you may be happy with the display as it is presented. Should that be the case, do nothing.

TEST VALIDITY. It is essential that you do this test by yourself without the use of references or outside resources. To do otherwise will destroy the validity of the analysis method selected for this evaluation.

GUESSING. If you want to guess, go ahead. You would anyway, even if I told you not to do so.

GRADING. Should you like to know the results of the test, you will have the opportunity to let me know at the end of the evaluation period.

DIAGNOSTIC POST TEST

A. The first item of interest is the TASK ANALYSIS.

1. When should a task analysis be done?_____

_____

2. By whom should the task analysis be done?_____

_____

3. Describe what information the task analysis provides.___

_____

_____

B. SELECTION OF PERSONNEL for participation in each test system evaluation is an area of critical importance.

1. Explain why you agree or disagree with this statement.

_____

_____

_____

2. Name two resource documents that will aid you in selection of test subjects: a._____ b._____

3. Briefly describe the basic characteristics of a typical test subject:_____

_____

_____

_____

C. WORKSPACE DESIGN AND ARRANGEMENT is the third area of concern.

1. Name two resource documents that will aid you in evaluating the physical layout of a workspace (i.e. cockpit or bridge). a._____ b._____

2. Name the analysis technique recommended for evaluating the arrangement of components within a workspace. _____

_____

3. Name the aspect of evaluating workspace design which considers the physical characteristics of intended human operators. _____

4. Name the two human body dimensions measured when evaluating the workspace design and arrangement.

   a. _____

   b. _____

D. Evaluating CONTROL PANEL DESIGN should be next on your list. CONTROLS, DISPLAYS, and AUDIO/VISUAL ALARMS are items which require specific attention.

1. Name two resource documents that will provide valuable guidelines for evaluating a control panel.

   a. _____

   b. _____

2. Name the analysis method/technique which is recommended for determining whether the controls and displays are positioned optimally: _____

3. List the guidelines recommended when deciding whether to use an audio alarm or a visual alarm. (DO NOT name resource documents -- list the actual guidelines.)

   a. _____

   b. _____

   c. _____

4. List six of the eight CONCEPTS for evaluating CONTROL DESIGN:

   a. _____

   b. _____

   c. _____

   d. _____

   e. _____

   f. _____

5. Select one of the concepts from question 4 and name four factors considered when evaluating this concept.

   concept: a._____

   factors: (1) _____

   (2) _____

   (3) _____

   (4) _____

6. Select another one of the concepts listed in question 4 and explain how this concept could be critical in preventing human errors.

   concept: a. _____

   explanation: _____

   _____

   _____

7. There are three classes of knobs, (1) discrete, (2) fractional, and (3) multiple reaction. Figure 1 shows four knobs. Select one knob for each of the controls displayed on the next page and place its corresponding number in the blanks provided.

HEATER	IGNITION SWITCH	RADIO FREQUENCY
OFF 3/4 1/4 1/2	OFF ON	50 60 70 80 90 100 110 120 130

a._____ b._____ c._____

Choice of knobs:

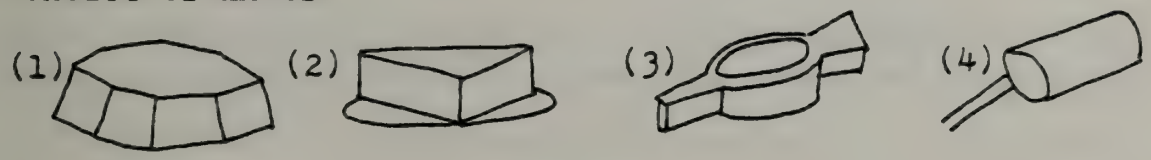
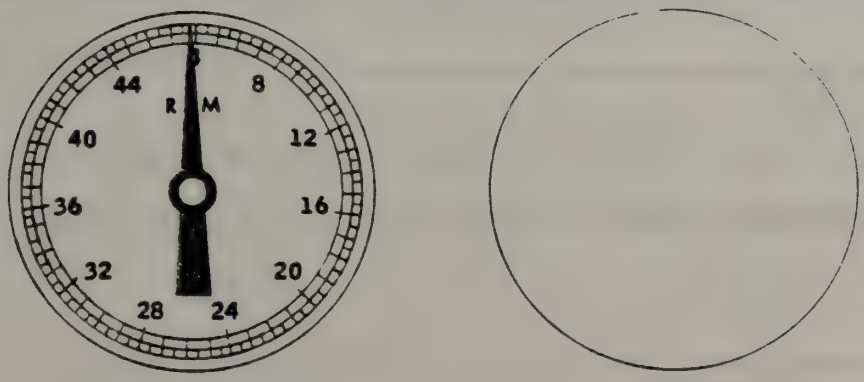


Figure 1.

8. If and only if you believe it is necessary to do so, redesign the dial in the space provided following recommended design practices. Put in all major and/or numbered markers. Minor markers need be illustrated only between the first two major or numbered markers. (Figure 2)



ORIGINAL DESIGN NEW DESIGN

Figure 2. Tachometer used in testing rotary equipment. The scale unit is .5 rpm. The operational range is 50 rpm.

E. The INFORMATION PROCESSING CAPABILITY of the human operator is a critical aspect of design. Even though all the controls, displays and alarms meet their requirements, the operators may still experience difficulty in performing their necessary tasks. These difficulties may be caused by the limitations on human information processing capabilities. There are three main areas in which these capabilities may be grouped. One of these is PHYSIOLOGICAL PROCESSING LIMITATIONS (PPL). Give an example for PPL and name the other two main areas:

1. PPL example: _____

2. second area: _____

3. third area: _____

F. Weapon systems function in real world environments, not in vacuums. The operator may therefore encounter a variety of ENVIRONMENTAL FACTORS which may effect his/her performance.

1. Name one resource document which provides guidelines in the area of environmental factors and their possible effects on human performance. _____

2. Name five environmental factors and for each factor explain what effect it could have on human performance:

	factor	effect
a.	_____	_____
b.	_____	_____
c.	_____	_____
d.	_____	_____
e.	_____	_____

G. There are ENVIRONMENTAL CONSIDERATIONS which need to be evaluated. Three of these are (1) ATMOSPHERIC CONDITIONS, (2) NOISE, and (3) WORK/REST SCHEDULES.

1. Define the term noise:_____

_____

_____

2. Give an example of an atmospheric condition which is a concern to and can be affected by a human factors evaluator:_____

_____

3. When do the greatest performance decrements occur during a watch-standing duty?

a. _____

b. _____

4. Listed below are UNITS OF MEASURE. In the space provided name what each of these measures, i.e.. in./length; lb./weight.

a. CPS/Hz _____

b. PSI _____

c. CLO _____

d. PTS/TTS _____

e. RAD _____

f. dB/PNDB _____

g. PPM _____

H. Choose the best answer(s). Place an "X" by your choice(s). One or more than one answer may be correct.

1. The overall objective(s) in taking a human factors engineering course is(are):

_____ 1. to obtain the human factors engineering background to do your job well.

_____ 2. to understand a specific person's capabilities and limitations.

_____ 3. to understand the precise military procedures involved in a human factors program.

_____ 4. to understand the importance of applying the concepts and priorities of human factors engineering in your job.

_____ 5. to be able to answer some questions on this #*!@#! test.

2. The main reason for poor system performance is human error. Which (if any) of the following are contributing factors?

_____ 1. inadequate consideration of human performance capabilities, skill limitations and response tendencies.

_____ 2. little standardization of 'controls'. (knobs, levers, etc.).

_____ 3. the fast developing pace of new technologies with which the human's capabilities cannot keep up.

_____ 4. people with too little education and too few skills being brought into the armed services.

_____ 5. inadequate human factors input into system man-machine interface.

POSTSCRIPT

This evaluation was originally designed to cover the entire course, lessons 1-40 over a period of 60 days. Murphy's Law was rolling full steam, however, and the evaluation had to be cut to 30 days and only 20 lessons. You all are the ones who lose out, though, because the last 20 lessons deal with quantifying human factors evaluations and practicing human factors concepts.

Recently, the Government Accounting Office, the Secretary of Defense and others have pointed out that the military is accepting weapons systems that can't fulfill their missions. They say that as a result we are not ready to meet our military obligations. Human error is pointed out as being one of the prime reasons for the unacceptable system performance. They also state that inadequate attention to human factors design during test and evaluation has set up the operator to make the error.

If we, the operational test directors, know what design factors can cause the human to make errors, we can help prevent them. Perhaps I'm a bit surrealistic, but I always thought our job was to deliver good and safe equipment to our military men and women and in doing so help save lives.

This human factors course may have been an assignment to you -- maybe even one you didn't like. Whether you wanted to take the course or not, I sincerely hope you have learned something. If you have, then the course is serving its purpose and I ask you to please continue with the other 20 lessons. Some flyer or sailor

will be out there thanking you for it. Who knows, it may even be you.

The course may not be perfect and it is for that reason the evaluation is being conducted. The questionnaires you will be given is your opportunity to tell me how to make it better. I ask for your continued dedication and co-operation while filling out the questionnaires. The feedback you provide will be invaluable.

Once again, thank you for your help and participation.

ANNEX E

CCS QUESTIONNAIRE

COMMAND COURSE SUPERVISOR QUESTIONNAIRE INSTRUCTIONS

Directions: Based upon your observations and your log entries during the last four weeks, complete this form. Upon completion, submit to the Evaluation Director at the Naval Postgraduate School for analysis. This Evaluation Director may ask for your assistance and for clarification during the Analysis Phase of this evaluation.

NAME_____ COMMAND_____

NUMBER OF STUDENTS_____ DATE_____

SAMPLE QUESTION.

(3) How frequently did students' questions/comments indicate:

	0-40%	41-60%	61-100%
a. they did not like coffee.	____	____	____
b. dissatisfaction with today's weather.	____	____	____

If half of all students' questions/comments relating to coffee indicated they didn't like it, then place an 'X' in the 41-60% column, as shown below.

If there are nine students' questions/comments relating to today's weather, and three are negative, then place an 'X' in the 0-40% column (3 ÷ 9 = 33.3%), as shown below.

	0-40%	41-60%	61-100%
a. they did not like coffee.	____	X	____
b. dissatisfaction with today's weather.	X	____	____

**There are 4 pages to this questionnaire, be sure to answer all.

COMMAND COURSE SUPERVISOR QUESTIONNAIRE

1. How frequently did students' questions/comments indicate dissatisfaction with the:

	0-40%	41-60%	61-100%
(a) LESSON BOOK MATERIALS:			
(1) information frames	____	____	____
(2) wrong answer frames	____	____	____
(3) questions at end of information frames	____	____	____
(4) answer choices at end of information frames	____	____	____
(5) correct answers	____	____	____
(6) course length	____	____	____
(7) format	____	____	____
(8) lesson length	____	____	____
(9) educational level of course content	____	____	____
(10) course content	____	____	____
(11) usefulness of the course	____	____	____
(12) amount of time spent on course	____	____	____
(13) terminology	____	____	____
(b) STUDENT SUPPLEMENT:			
(1) supplement in general	____	____	____
(2) graphs	____	____	____
(3) charts	____	____	____
(4) symbology	____	____	____
(5) legends	____	____	____
(6) lesson outlines	____	____	____

2. How frequently did students' questions/comments indicate dissatisfaction with the:

		0-40%	41-60%	61-100%
(c)	RESOURCE DOCUMENTS:			
	(1) documents (in general)	_____	_____	_____
	(2) 1472C	_____	_____	_____
	(3) 1474B	_____	_____	_____
(d)	PRETEST:			
	(1) pretest (in general)	_____	_____	_____
(e)	POST TEST			
	(1) post test (in general)	_____	_____	_____

3. How frequently did students' questions/comments indicate that initial attitudes about human factors were:

(a) positive	_____	_____	_____
(b) negative	_____	_____	_____
(c) neutral	_____	_____	_____

4. How frequently did students' questions/comments indicate that final attitudes about human factors were:

(a) postive	_____	_____	_____
(b) negative	_____	_____	_____
(c) neutral	_____	_____	_____

5. How frequently did students' questions/comments indicate:

(a) an irritation with course materials.	_____	_____	_____
(b) that the course provided nothing new.	_____	_____	_____
(c) that human factors training was unnecessary.	_____	_____	_____
(d) that the learning materials were more hindering than helpful.	_____	_____	_____
(e) that the course was a a waste of time.	_____	_____	_____

STUDENT INFORMATION

6. How many students failed to complete 20 lessons? _____

7. How many students continued beyond lesson 20? _____

8. How many students completed exactly 20 lessons? _____

9. How many students requested to keep the Student Supplement? _____

10. How many students requested to keep the entire course? _____

ADDITIONAL COMMENTS:

FROM PAGE 73

(3) YOU'RE RIGHT, INTENSE NOISE THAT IS PRESENTED PERIODICALLY IS MOST DISTRACTING FOR PERFORMANCE.

OK, SO FAR YOU'VE COVERED SOME OF THE IMPORTANT PHYSICAL ASPECTS OF NOISE, AND HOW THEY AFFECT PERFORMANCE. NOW, LET'S GET MORE SPECIFIC AND DEAL WITH SEVERAL WAYS THIS TYPE OF INFORMATION IS UTILIZED BY THE MILITARY.

IN MANY MILITARY SITUATIONS, IT IS IMPORTANT TO KNOW THE LIMITS OF NOISE DETECTABILITY AND NONDETECTABILITY. THIS INFORMATION IS PART OF MIL-STD-1474B, WHICH PRESENTS A GENERAL OVERVIEW OF NOISE LIMITS FOR ARMY MATERIEL. TABLE 3 ON PAGE 24 DEPICTS THE UPPER LIMITS THAT SHOULD NOT BE EXCEEDED BY THOSE ITEMS OF EQUIPMENT HAVING AN AURAL NONDETECTABILITY REQUIREMENT. THUS, FOR INSTANCE, IF YOU WANTED TO BE SURE A PARTICULAR PIECE OF EQUIPMENT YOU WERE DESIGNING COULD NOT BE HEARD BY ANYONE STANDING MORE THAN 30 METERS AWAY, ITS NOISE OUTPUT COULD NOT EXCEED 43 DB AT 500 HZ. WE HOPE YOU SEE HOW THIS FIGURE IS DERIVED. TO MAKE SURE YOU UNDERSTAND HOW TO MOVE THROUGH THIS TABLE, LET'S GO THROUGH IT STEP-BY-STEP.

SUPPOSE YOU WERE REQUIRED AS THE CHIEF HUMAN FACTORS ENGINEER, TO DESIGN A SUPPLY TRUCK THAT COULD NOT BE HEARD 100 METERS AWAY. YOU HAVE INFORMATION THAT THE ENGINE HUM FALLS IN THE RANGE OF 1000-2000 HZ. NOW, YOUR TASK WOULD BE TO MUFFLE THE LOUDNESS OF THE ENGINE SO THAT IT DOES NOT EXCEED THE CRITICAL INTENSITY AND BE HEARD AT 100 METERS.

OK, BY LOOKING AT THE TABLE, IF A 1000-2000 HZ NOISE NEEDS TO BE MADE INAUDIBLE AT OR ABOVE 100 METERS, YOU NEED TO MOVE DOWN THE 'NOMINAL NON-DETECTABILITY DISTANCE' COLUMN UNTIL YOU REACH 100 METERS. THEN MOVE ACROSS UNTIL YOU REACH 2K (OR 2000 HZ). THIS DECIBLE LIMIT IS HIGHER THAN THE 1000 HZ NOISE LEVEL, SO YOU ADOPT THIS LEVEL IF YOU DO NOT WANT YOUR TRUCK TO BE HEARD BY ANYONE 100 METERS AWAY.

THIS SAME PRINCIPLE CAN BE APPLIED TO DETERMINE HOW LOUD A SOUND MUST BE IN ORDER TO BE HEARD FROM A PARTICULAR DISTANCE. STILL USING TABLE 3, YOU CAN DISCOVER HOW LOUD AN ALARM MUST BE (AROUND 8000 HZ) IN ORDER TO BE HEARD 500 METERS AWAY. WITH THIS INFORMATION, WHAT WOULD THE CORRECT ANSWER BE?

(1) THE ALARM MUST BE 49 DB TO BE HEARD 500 METERS AWAY. TURN TO PAGE 37.
(2) THE ALARM MUST BE AT LEAST 67 DB TO BE HEARD 500 METERS AWAY. TURN TO PAGE 32.
(3) FROM THE INFORMATION GIVEN, A DEFINITE ANSWER CANNOT BE OBTAINED. TURN TO PAGE 82.
(4) NONE OF THESE ANSWERS ARE CORRECT. TURN TO PAGE 87.

FROM PAGE 44

(3) THE RANGES GIVEN FOR BOTH NOISE AND TEMPERATURE REFLECT VALUES THAT TEND TO INCREASE WATCH-KEEPING BEHAVIOR RATHER THAN DETRACT FROM IT. IT MIGHT BE GOOD TO GO BACK AND REREAD THIS SECTION ON ENVIRONMENTAL VARIABLES THAT AFFECT VIGILANCE. RETURN TO PAGE 44.

FROM PAGE 78

(2) THIS ANSWER COVERS MOST OF THE WAYS TO PREVENT HYPOXIA, BUT OXYGEN MASKS ARE NOT USED IF THE CABIN IS SUFFICIENTLY PRESSURIZED. RETURN TO PAGE 78.

FROM PAGE 70

(3) THESE FIGURES ARE OFF TOO FAR TO THE LEFT OF THE GRAPH. RETURN TO PAGE 70.

ANNEX F

STUDENT ATTITUDE QUESTIONNAIRE

STUDENT QUESTIONNAIRE INSTRUCTIONS

PURPOSE: The main purpose of this questionnaire is to obtain information regarding the objectives, content, design and presentation of the Human Factors Engineering (HFE) Self-Paced Course. Your answers will help to determine what actions must be taken to improve the course and the quality of human factors training and education. Your honest opinions are, therefore, essential.

INSTRUCTIONS: I have no need to know who you are personnally. No effort will be made to identify you. However, for analysis purposes, it is necessary to have your Student Identification number (SIF). No one besides myself will see these questionnaires and no individual information will be related to your command.

Before you begin, your Command Course Supervisor (CCS) will show you an example of an "information frame" and a "wrong answer frame". This will provide clarification of terminology used within this questionnaire.

Directions for answering the questions are provided below:

SAMPLE QUESTION

(3) What types of schools have you attended? Circle your answer(s).

1 2 3 4 5

Types of Schools
1. pre-school
2. elementary
3. junior high
4. senior high
5. 4-yr high

If you attended elementary school, you should circle the number 2, as has been done below, since the number 2 corresponds to elementary school. If, in addition, you also attended a 4-year high school, you should also circle the number 5, as it corresponds to 4-year high school.

1 (2) 3 4 (5)

SAMPLE QUESTION.

(4) In taking college courses, the college preparatory courses taken in your high school were

_____ very effective

_____ effective

_____ borderline

_____ ineffective

_____ very ineffective

If you felt the college preparatory courses you took in high school did absolutely nothing to help you through college, place an 'X' in front of "very ineffective", as shown below:

_____ very effective

_____ effective

_____ borderline

_____ ineffective

__X__ very ineffective

If you have any questions, please ask your CCS for assistance. The questionnaire must be returned to your CCS within two working days. Be sure to double check that you have answered all questions.

HUMAN FACTORS ENGINEERING SELF-INSTRUCTION COURSE OBJECTIVES

Upon completion of the Human Factors Engineering Course, the student will demonstrate the following capabilities and knowledge:

1. An understanding of common terms used in human factors engineering.
2. A familiarity with human factors references and an ability to use them.
3. An awareness of potential sources of technical information on major human factors topics.
4. An understanding of the goals of human factors engineering in a materiel development program.
5. An ability to integrate human factors principles in a DOD sponsored program.
6. An ability to determine human performance requirements in a systems concept.
7. An understanding of the kinds of factors and forces which affect human performance and an ability to identify and measure them.
8. An awareness of the differences between field and laboratory measurements.
9. An awareness of what "experimental control" measures are necessary for any test involving human performance and the effects in their absence.
10. An understanding of basic statistical techniques, such as analysis of variance.
11. An ability to calculate human performance reliability.
12. An ability to formulate performance measures for the dependent variables of time and error.
13. An ability to analyze human performance data within the context of "system effectiveness" and "system reliability."
14. An understanding of the major techniques used by human factors specialists during system synthesis, design, and development.
15. A familiarity with task analyses.
16. An awareness of the relationship between human factors engineering and the engineering specialists of reliability, maintainability and safety.
17. An ability to interpret and apply the standards and specifications of the human factors engineering community.

STUDENT

QUESTIONNAIRE

A. Course Content and Objectives.

Refer to the "Course Objectives" sheet on the next page and answer the following by circling your answer(s).

(1) Which of the 17 objectives listed have been supported (taught) by the lessons within the first half of the Human Factors Engineering Self-Instruction Course?

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

(2) Which of the 17 objectives listed describe a skill necessary to test and evaluate a system's human factors aspects?

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

(3) Which of the 17 objectives listed would help you do your job?

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

B. Course Design

(1) The sequence in which the various lesson topics were presented was

_____ very effective

_____ effective

_____ borderline

_____ ineffective

_____ very ineffective

(2) The way in which each concept was developed was

_____ very effective

_____ effective

_____ borderline

_____ ineffective

_____ very ineffective

(3) Direction were given to read the information presented in each frame, answer the question at the end of each frame and go to the page referenced by the selected answer. If the answer was incorrect, the student was referred back to the previous page to select another answer. If the answer was correct, the student proceeded with the next "information frame". This format was

_____ very effective

_____ effective

_____ borderline

_____ ineffective

_____ very ineffective

Comment:

(4) How frequently was the re-enforcement or reteaching provided in the "wrong answer frame" sufficient to choose the "correct" answer?

_____always _____frequently _____sometimes _____seldom _____never

(5) How frequently was the answer to the question at the end of each "information frame" suggested or provided in <u>preceding</u> course material?

_____ always
_____ frequently
_____ sometimes
_____ seldom
_____ never

(6) How frequently was the answer to the question at the end of each "information frame" suggested or provided in course material <u>following</u> the question?

_____ always
_____ frequently
_____ sometimes
_____ seldom
_____ never

(7) The quality of the questions at the end of each "information frame" was

_____ excellent
_____ good
_____ borderline
_____ bad
_____ very bad

(8) The quality of the answer choices for each question at the end of each "information frame" was

_____ excellent
_____ good
_____ borderline
_____ bad
_____ very bad

C. Course Presentation

(9) Participation in the HFE course without the aid of an on-site instructor was

_____ very effective
_____ effective
_____ borderline
_____ ineffective
_____ very ineffective

(10) How frequently was assistance required of the Command Course Supervisor?

____always ____frequently ____sometimes ____seldom ____never

(11) How frequently were words used which required defining by an outside source (dictionary, person, etc.)?

____always ____frequently ____sometimes ____seldom ____never

D. Student Supplement

(12) How effective/ineffective were each of the elements listed below in aiding your understanding of the concepts presented in the course material?

	Very effective	Effective	borderline	Ineffective	Very Ineffective
tables	_____	_____	_____	_____	_____
charts	_____	_____	_____	_____	_____
graphs	_____	_____	_____	_____	_____
illustrations	_____	_____	_____	_____	_____
symbology	_____	_____	_____	_____	_____
legends	_____	_____	_____	_____	_____
terminology	_____	_____	_____	_____	_____
lesson outlines	_____	_____	_____	_____	_____
arrangement of tables, graphs, etc.	_____	_____	_____	_____	_____

(13) How do you feel about the student supplement as a reference book and human factors guideline during test and evaluation planning stages?

_____ extremely useful
_____ of considerable use
_____ of use
_____ not very useful
_____ of no use

(14) The information given with figures and tables (charts and graphs) to provide clarity and meaning to each was

_____ extremely useful
_____ of considerable use
_____ of use
_____ not very useful
_____ of no use

(15) The implied ideas and meanings represented by symbols and legends in the student supplement were

_____ always understood
_____ frequently understood
_____ sometimes understood
_____ seldom understood
_____ never understood

E. Resource Documents

(16) The HFE course materials made use of the resource documents listed below

	very easy	easy	borderline	difficult	very difficult
1472B	_____	_____	_____	_____	_____
1474B	_____	_____	_____	_____	_____
HDBK 759	_____	_____	_____	_____	_____

(17) Use of the resource documents listed below in planning human factors tests for a new system is

	very easy	easy	borderline	difficult	very difficult
1472B	_____	_____	_____	_____	_____
1474B	_____	_____	_____	_____	_____
HDBK 759	_____	_____	_____	_____	_____

F. Human Factors Attitudes

(18) How do YOU FEEL about including a human factors test in the evaluation of a new piece of equipment or system?

_____ very important

_____ important

_____ borderline

_____ unimportant

_____ very unimportant

G. Miscellaneous

(19) The adventures of Lt. I. M. Eager were tracked throughout the HFE course. The stories about Lt. Eager were

_____ always effective

_____ frequently effective

_____ sometimes effective

_____ seldom effective

_____ never effective

COMMENT:

(20) How frequently did the factors listed below adversely affect your completion of the lessons in the first half of the course?

	always	frequently	sometimes	seldom	never
Experience	_____	_____	_____	_____	_____
Education	_____	_____	_____	_____	_____
Time	_____	_____	_____	_____	_____
Job load	_____	_____	_____	_____	_____
Course Length	_____	_____	_____	_____	_____
Format	_____	_____	_____	_____	_____
Terminology	_____	_____	_____	_____	_____
Design	_____	_____	_____	_____	_____
TAD (temporary additional duty)	_____	_____	_____	_____	_____

(**) Please identify, in the space below, any specific problems you had with the following:

LESSONS BOOKS:

STUDENT SUPPLEMENT:

RESOURCE DOCUMENTS:

PRETEST:

POST TEST:

(***) Would you like to keep a copy of the HFE course?

_____ yes _____ no

(***) Would you like to keep a copy of the student supplement?

_____ yes _____ no

(***) Would you like to know your test scores?

_____ yes _____no

(***) Would you like to see the final report on the HFE Self-Paced Course?

_____ yes _____no

WHAT IS YOUR Student Identification Number? _____

ANNEX G

COURSE OBJECTIVES QUESTIONNAIRE

COURSE OBJECTIVES EVALUATION

NAME _____

COMMAND _____

POSITION/TITLE _____

RESPONSIBILITIES _____

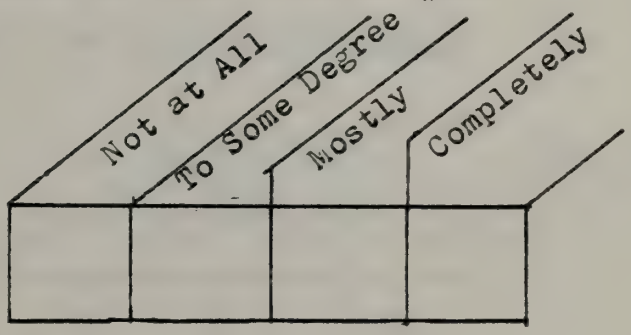
_____

EXPERIENCE IN COURSE EVALUATIONS _____(yrs.) _____(mos.)

TIME AT THIS COMMAND _____(yrs.) _____(mos.)

The six characteristics listed on page one have been established by NAVEDTRA 106A as criteria by which instructional learning objectives are to be judged. The 17 learning objectives listed on pages two and four will, therefore, be evaluated according to how completely they meet the six criteria as explained on the next two pages.

Directions: Assess each learning objective according to each of the six criteria. Place criteria numbers (1,2,3,4,5, and 6) in the spaces to the right of each learning objective, according to how completely each objective satisfies each of the criteria. Each criteria should be rank ordered from "Not at All" to "Completely".



SAMPLE:

A. A student will be able to correctly solve quadratic equations.

CRITERIA FOR COURSE OBJECTIVES

1. Objectives must be a statement of student behavior (action), such as the creation of a product or some other overt act, which can be accepted as evidence that the intended outcome has occurred.

2. The behavior must describe specifically all outcomes that will demonstrate that learning has occurred.

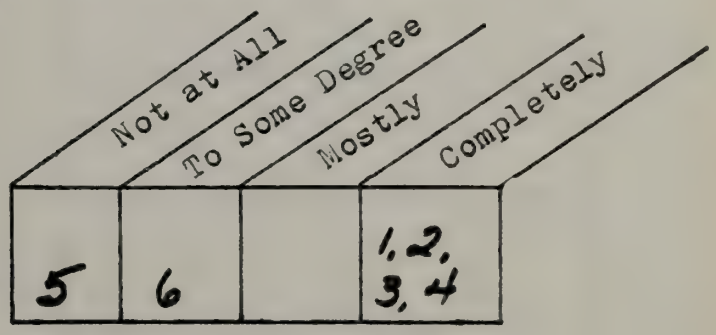
3. The student behavior called for must be capable of observation and evaluation within the learning and testing environments.

4. The objective must be stated in learner rather than "teacher" terms, i.e., actions which the student will perform rather than what the instructional materials will "say or do".

5. There must be a standard against which the student behavior will be measured. It must be fully specified.

6. The statement of the conditions under which the student behavior will occur must be fully specified.

If you feel that objective "A" fulfills criteria 1,2,3, and 4 completely, then place the numbers 1,2,3, and 4 in the blank under "Completely" as shown below. If you feel that objective "A" does not meet criteria 5 at all, place a "5" under "Not at All". If it meets criteria 6 to some extent, but needs quite a bit of attention, then place a "6" under "To Some Degree", as show below.



A. A student will be able to correctly solve quadratic equations.

If you have any questions or comments regarding this evaluation, please feel free to contact me or write them in the space provided at the end of this evaluation.

Lt. Martha M. Fleming
Naval Postgraduate School
SMC # 1340
Monterey, California 93940

Autovon: 878-2536
Commercial: 408-646-2536

LEARNING OBJECTIVES

	Not at All	To Some Degree	Mostly	Completely
1. An understanding of common terms used in human factors engineering.				
2. A familiarity with human factors references and an ability to use them.				
3. An awareness of potential sources of technical information on human factors topics.				
4. An understanding of the goals of human factors engineering in a material development program.				
5. An ability to integrate human factors principles in a Department of Defense sponsored program.				
6. An ability to determine human performance requirements in a systems concept.				
7. An understanding of the kinds of factors and forces which affect human performance and an ability to identify and measure them.				
8. An awareness of the differences between field and laboratory measurements.				
9. An awareness of what "experimental control" measures are necessary for any test involving human performance and the effects in their absence.				
10. An understanding of basic statistical techniques, such as analysis of variance.				
11. An ability to calculate human performance reliability.				
12. An ability to formulate performance measures for the dependent variables of time and error.				

CRITERIA FOR COURSE OBJECTIVES

1. Objectives must be a statement of student behavior (action), such as the creation of a product or some other overt act, which can be accepted as evidence that the intended outcome has occurred.

2. The behavior must describe specifically all outcomes that will demonstrate that learning has occurred.

3. The student behavior called for must be capable of observation and evaluation within the learning and testing environments.

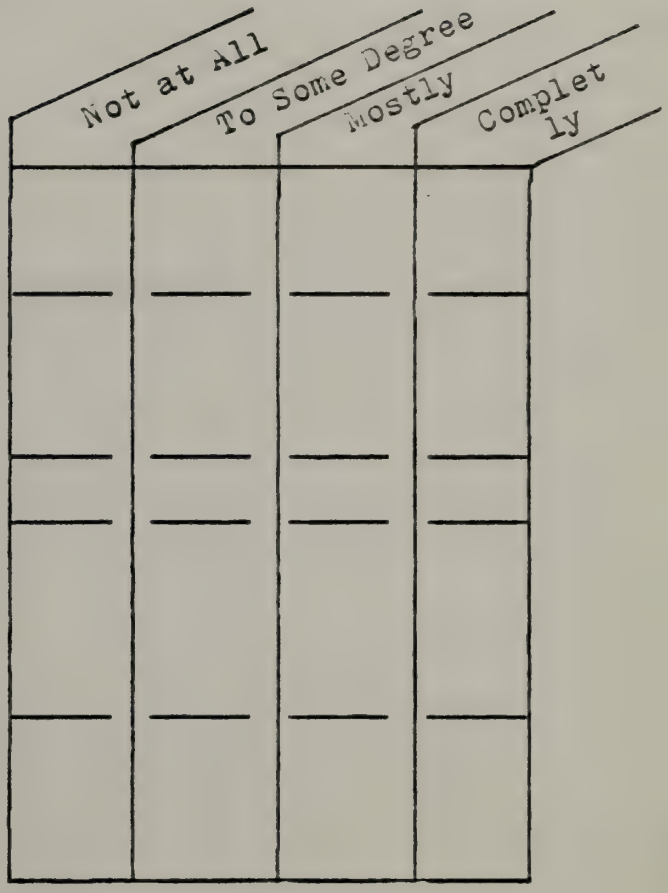
4. The objective must be stated in learner rather than "teacher" terms, i.e., actions which the student will perform rather than what the instructional materials will "say or do".

5. There must be a standard against which the student behavior will be measured. It must be fully specified.

6. The statement of the conditions under which the student behavior will occur must be fully specified.

NAVEDTRA 106A

LEARNING OBJECTIVES



13. An ability to analyze human performance data within the context of "system effectiveness" and "system reliability".

14. An understanding of the major techniques used by human factors specialists during system synthesis, design, and development.

15. A familiarity with task analyses.

16. An awareness of the relationship between human factors engineering and the engineering specialists of reliability, maintainability and safety.

17. An ability to interpret and apply the standards and specifications of the human factors engineering community.

A. Are these the criteria by which you judge learning objectives?

(Circle one): YES NO

If the above answer was "NO", please provide a copy of the criteria you do use.)

B. Do you approve of these 6 characteristics being used as criteria for judging learning objectives? (Circle one):

YES NO

C. Why?:

APPENDIX F

DEMOGRAPHIC AND PRE-POST TEST DATA

Demographic and Pre-Post Test Score Data for the Control Group at Each of Four Test Sites (n=26)

SIF #	Paygrade	Education	Time on Station (yrs & mos)	HFE Training	T & E Experience	Pretest Score (# of pts.)	Post Test Score (# of pts.)
0117	0-5	PGS	1-10	OTD CRS	T & E	64.0	47.5
18	0-5	PGS	1- 4	OTD CRS	T & E	80.0	59.5
19	0-4	PGS	2- 1	OTD CRS	T & E	66.0	19.5
20	0-4	Col.Deg.	3- 0	OTD CRS	T & E	56.0	29.0
21	0-4	Col.Deg.	9	OTD CRS	T & E	71.0	53.5
22	0-4	PGS	2-10	OTD CRS	T & E	76.0	76.5
23	0-4	Col.Deg.	1- 3	OTD CRS	T & E	88.0	75.1
24	0-4	PGS	2- 7	OTD CRS	T & E	87.0	35.5
25	0-4	PGS	2- 6	OTD CRS	T & E	88.0	77.5
26	0-4	Col.Deg.	2- 2	OTD CRS	T & E	71.0	56.0
27	0-3	PGS	1- 6	OTD CRS	T & E	109.0	37.5
28	0-3	Col.Deg.	2- 0	OTD CRS	T & E	52.0	19.0
29	E-8	High Scol	2- 0	OTD CRS	T & E	47.0	44.5
30	E-6	2 Coll.	2-10	OTD CRS	T & E	67.5	48.0
31	GS-15	Col.Deg.	20- 0	OTD CRS	T & E	70.0	45.5
32	GS-14	PGS	10- 0	OTD CRS	T & E	47.0	35.5
0206	0-3	Col.Deg.	2- 0	OTD CRS	T & E	50.0	52.5
07	0-3E	Col.Deg.	1- 7	OTD CRS	T & E	80.0	56.0
08	0-3E	2 Coll.	1- 0	OTD CRS	T & E	70.0	54.0
09	E-7	2 Coll.	1- 8	OTD CRS	T & E	53.0	37.5
10	E-5	Col.Deg.	1- 1	OTD CRS	T & E	62.0	39.5
0302	E-9	Col.Deg.	7- 2	2 wk HF	T & E	83.0	78.0
0406	0-3	PGS	3- 0	OJT	T & E	77.0	45.5
07	E-3	3 Coll.	10	OJT	T & E	65.5	47.5
08	GS-5	Col.Deg.	4	OJT	T & E	82.0	50.5
03	0-2	PGS	6	OJT	T & E	63.0	71.5
						$\bar{X}$ = 70.19	$\bar{X}$ = 49.70
						S.D.= 14.85	S.D.= 16.48

Demographic and Pre-Post Test Score Data for the Course Group at Each of Four Test Sites

SIF #	Paygrade	Education	Time on Station (yrs & mos)	HFE Training	T & E Experience	Pretest Score (n=26) (# of pts.)	Post Test Score (n=16) (# of pts.)
0102*	0-5	PGS	1- 0	Books	T & E	47.0	95.0
04*	0-4	PGS	3	---	T & E	72.0	107.5
05*	0-4	PGS	1- 5	---	T & E	57.0	66.5
07*	E-8	Col.Deg.	1- 3	OTD CRS	T & E	55.0	95.5
09*	E-8	Col.Deg.	15 days	---	T & E	52.0	59.0
11*	E-6	High Scol.	3	OTD CRS	T & E	58.0	65.8
12*	E-7	2 Coll.	2- 0	OTD CRS	T & E	77.5	50.5
13*	E-6	High Scol.	1- 0	OTD CRS	T & E	57.0	77.0
15*	E-6	High Scol.	2- 3	OTD CRS	T & E	34.0	85.0
16*	GS-13	PGS	3	OTD CRS	T & E	77.0	110.0
0202*	0-3	Col.Deg.+	1- 2	OTD CRS	T & E	90.0	104.0
0301*	E-9	High Scol.	7- 3	---	T & E	72.0	103.2
0401*	0-2	Col.Deg.	21 days	OJT	T & E	75.0	100.0
02*	0-3	PGS	1- 6	OJT	T & E	101.5	148.5
04*	GS-7	Col.Deg.	6	OJT	T & E	91.0	119.0
05*	GS-12	PGS	2 days	OJT	T & E	56.0	107.7
0101	0-5	PGS	6-10	---	T & E	83.0	
03	0-4	Col.Deg.	1- 0	OTD CRS	T & E	91.0	
06	E-9	High Scol.	2-10	OTD CRS	T & E	50.0	
08	E-7	High Scol.	6	OTD CRS	T & E	62.0	
10	E-7	High Scol.	3	---	T & E	20.0	
14	E-6	2 Coll.	1- 6	OTD CRS	T & E		
0201	0-3	Col.Deg.	2- 0	OTD CRS	T & E	74.0	
03	0-4	Col.Deg.	2	---	T & E	60.0	
04	E-7	High Scol.	1- 1	OTD CRS	T & E	55.0	
05	E-6	High Scol.	10	OTD CRS	T & E	47.0	

* Completed at least 20 lessons.

$\bar{X}$ = 64.73 $\bar{X}$ = 93.39
S.D.= 18.70 S.D.= 25.14

APPENDIX G

POST TEST RAW SCORES

Table 26

Post Test Raw Scores for the Control Group

SIF No.	A				B				C					D								E				F			G					H			GRAND TOTAL
	1	2	3	T	1	2	3	T	1	2	3	4	T	1	2	3	4	5	6	7	8	T	1	2	3	T	1	2	T	1	2	3	4	T	1	2	T	
KEY	3.0	3.0	3.0	9.0	5	4	5	14.0	4	2	2	4	12.0	4	2.0	9	12.0	10.0	7.0	6	15.0	65.0	3	3	3	9.0	2	25.0	27.0	5	5	6	14	30.0	5	5	10.0	176.0
0117	1.0	1.5	0	2.5	5	0	0	5.0	0	0	0	0	0	0	0	8	0	0	0	2	4.0	14.0	0	0	0	9.0	0	7.0	7.0	2	0	0	9	11.0	4	4	8.0	47.5
0118	3.0	1.5	0	4.5	5	0	3	8.0	0	0	0	0	0	0	0	8	0	0	0	2	7.0	17.0	0	0	0	0	0	5.0	5.0	2	5	0	10	17.0	4	4	8.0	59.5
0119	1.0	1.5	0	2.5	5	0	0	5.0	0	0	0	0	0	0	0	0	0	0	0	2	0	2.0	0	0	0	0	0	0	0	2	0	0	0	2.0	4	4	8.0	19.5
0120	0	0	0	0	5	0	0	5.0	0	0	0	0	0	0	0	0	0	0	0	6	8.0	14.0	0	0	0	0	0	0	0	0	0	0	4	4.0	4	2	8.0	29.0
0121	0	3.0	3.0	6.0	5	0	2	7.0	0	0	0	0	0	0	0	0	0	0	0	0	8.0	8.0	3	0	0	3.0	0	6.0	6.0	5	0	.5	10	15.5	4	4	8.0	53.5
0122	0	1.5	3.0	4.5	4	0	1	5.0	0	0	0	0	0	0	0	6	8.0	5.0	6.0	2	8.0	35.0	0	0	0	0	0	7.0	7.0	5	5	0	8	18.0	4	3	7.0	76.5
0123	3.0	1.5	1.0	5.5	3	0	1	4.0	0	0	0	0	0	0	0	9	4.0	1.7	3.0	6	11.0	34.7	0	2	2	4.0	0	6.0	6.0	2	0	0	10	12.0	4	5	9.0	75.1
0124	0	1.5	0	1.5	4	0	0	4.0	0	0	0	0	0	0	0	0	0	0	0	6	0	6.0	0	0	0	0	0	6.0	6.0	2	0	0	6	8.0	5	5	10.0	35.5
0125	3.0	2.0	3.0	8.0	5	0	0	5.0	0	0	0	0	0	0	0	3	5.5	.5	4.5	6	11.0	30.5	0	0	0	0	0	13.0	13.0	2	3	0	9	14.0	4	3	7.0	77.5
0126	3.0	1.5	0	4.5	4	0	3	7.0	0	0	0	0	0	0	0	7	.5	2.0	0	6	0	15.5	0	0	0	0	0	8.0	8.0	2	5	0	6	13.0	4	4	8.0	56.0
0127	3.0	0	3.0	6.0	4	0	0	4.0	0	0	0	0	0	0	0	2	0	0	0	2	0	4.0	0	0	0	0	0	0	0	4	5	.5	4	14.5	4	5	9.0	37.5
0128	2.0	0	1.5	3.5	3	0	0	3.0	0	0	0	0	0	0	0	0	.5	0	0	2	0	2.5	0	0	0	0	0	0	0	1	0	0	2	3.0	4	3	7.0	19.0
0129	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	11.0	17.0	0	0	0	0	0	9.0	9.0	2	0	.5	8	11.5	4	3	7.0	44.5
0130	0	0	0	0	3	0	4	7.0	0	0	0	4	4.0	0	0	6	0	0	0	4	9.0	19.0	0	0	0	0	0	0	0	2	0	0	7	9.0	4	5	9.0	48.0
0131	3.0	1.5	1.5	6.0		0	2	3.5	2	0	0	0	2.0	0	0	0	0	0	0	2	8.0	10.0	0	0	0	0	0	4.0	4.0	4	0	0	8	12.0	4	4	8.0	45.5
0132	2.0	0	.5	2.5	1	0	1	2.0	0	0	0	0	0	0	0	0	0	0	0	4	1.0	5.0	0	0	0	0	0	12.0	12.0	0	0	0	7	7.0	4	3	7.0	35.5
0206	0	1.5	3.0	4.5	2	0	2	4.0	0	0	0	0	0	0	0	1	0	0	0	2	14.0	17.0	0	0	0	0	0	7.0	7.0	2	5	0	5	12.0	4	4	8.0	52.5
0207	3.0	0	1.5	4.5	5	0	0	5.0	0	0	0	0	0	0	0	0	0	0	0	6	15.0	21.0	0	0	0	0	0	0	0	5	0	.5	9	15.5	5	5	10.0	56.0
0208	0	0	3.0	3.0	5	0	0	5.0	0	0	0	0	0	0	0	0	0	0	0	6	7.0	13.0	0	0	0	0	0	6.0	6.0	5	5	0	8	18.0	4	5	9.0	54.0
0209	3.0	1.5	0	4.5	0	0	2	2.0	0	0	0	0	0	0	0	0	0	0	0	4	8.0	12.0	0	0	0	0	0	0	0	2	5	0	5	12.0	4	3	7.0	37.5
0210	2.0	1.5	0	3.5	4	0	2	6.0	0	0	0	0	0	0	0	0	0	0	0	6	0	6.0	0	0	0	0	0	0	0	2	5	0	7	14.0	5	5	10.0	39.5
0302	1.5	1.5	3.0	6.0	2	0	0	2.0	0	0	0	0	0	2	0	4	4.3	2.6	7.0	2	10.0	31.9	0	0	0	0	0	18.0	18.0	3	0	0	9	12.0	4	4	8.0	77.9
0403	3.0	3.0	1.5	7.5	5	0	0	5.0	0	0	2	4	6.0	0	0	5	0	0	0	6	8.0	19.0	0	0	0	0	0	9.0	9.0	5	0	3	8	16.0	4	5	9.0	71.5
0406	3.0	1.5	3.0	7.5	4	0	0	4.0	0	0	2	0	2.0	0	0	0	0	0	0	2	0	2.0	0	0	0	0	0	14.0	14.0	2	0	0	8	10.0	3	3	6.0	45.5
0407	0	1.5	0	1.5	3	0	0	3.0	0	0	0	0	0	0	0	0	0	0	0	4	0	4.0	0	0	0	0	0	14.0	14.0	2	5	0	10	17.0	3	5	8.0	47.5
0408	0	1.5	3.0	4.5	3	0	2	5.0	0	0	0	0	0	0	0	0	0	0	0	2	0	2.0	0	0	0	0	0	8.0	8.0	5	5	3	10	23.0	3	5	8.0	50.5
X				5.12				4.44					.54									13.93				.27			6.12					12.35			8.12	49.70
S.D.				5.56				1.77					1.42									10.04				.94			5.11					4.79			1.0.	16.48

Table 27

Post Test Raw Scores for the Course Group

SIF	A				B				C					D								E				F			G					H			GRAND
No.	1	2	3	T	1	2	3	T	1	2	3	4	T	1	2	3	4	5	6	7	8	T	1	2	3	T	1	2	T	1	2	3	4	T	1	2	T	TOTAL
KEY	3.0	3.0	3.0	9.0	5	4	5	14.0	4	2	2	4	12.0	4	2.0	9	12.0	10.0	7.0	6	15.0	65.0	3	3	3	9.0	2	25.0	27.0	5	5	6	14	30.0	5	5	10.0	176.0
0102	3.0	1.5	0	4.5	5	0	2	7.0	0	2	2	0	4.0	0	0	6	4.0	10.0	5.5	4	8.0	37.5	0	0	0	0	0	16.0	16.0	3	5	3	7	17.0	4	4	8.0	95.0
0104	3.0	1.5	1.5	6.0	5	0	5	10.0	4	2	2	4	12.0	4	0	9	0	0	0	4	12.0	29.0	3	3	0	6.0	0	10.5	10.5	5	5	3	12	25.0	4	5	9.0	107.5
0105	3.0	1.5	3.0	7.5	3	0	1	4.0	0	2	2	0	4.0	0	0	6	3.0	2.0	2.0	4	7.0	23.0	0	0	0	0	0	10.0	10.0	1	0	2	7	10.0	4	3	7.0	66.5
0107	3.0	3.0	2.0	8.0	3	2	4	9.0	2	0	2	0	4.0	0	0	9	4.5	0	7.0	6	8.0	34.5	3	0	0	3.0	0	15.0	15.0	3	0	0	10	13.0	4	5	9.0	95.5
0109	3.0	3.0	0	6.0	1	4	0	5.0	4	2	2	0	8.0	4	2.0	9	0	0	0	2	8.0	25.0	0	0	0	0	0	0	0	0	0	0	6	6.0	5	4	9.0	59.0
0111	3.0	1.5	0	4.5	4	0	2	6.0	0	0	0	0	0	0	0	0	4.0	2.7	.7	6	15.0	28.3	0	0	0	0	0	4.0	4.0	3	5	0	8	16.0	5	2	7.0	65.8
0112	0	1.5	2.0	3.5	3	0	3	6.0	0	0	2	4	6.0	0	0	0	0	0	0	2	12.0	14.0	0	0	0	0	0	4.0	4.0	2	0	0	6	8.0	4	5	9.0	50.5
0113	1.0	1.5	1.0	3.5	3	2	1	6.0	2	0	0	0	2.0	0	0	0	6.0	4.5	7.0	2	8.0	27.5	0	0	0	0	2	9.0	11.0	2	5	3	9	19.0	5	3	8.0	77.0
0115	3.0	1.5	1.0	5.5	5	4	1	10.0	4	1	0	4	9.0	2	.5	3	0	0	0	6	8.0	19.5	0	0	0	0	0	14.0	14.0	5	5	3	6	19.0	5	3	8.0	85.0
0116	3.0	3.0	3.0	9.0	5	0	2	7.0	0	0	0	0	0	0	2.0	9	6.0	8.5	4.5	0	8.0	38.1	3	3	0	6.0	0	15.0	15.0	5	5	3	13	26.0	5	4	9.0	110.0
0202	3.0	1.5	1.0	5.5	5	4	3	12.0	4	0	2	4	10.0	4	0	3	2.7	1.4	5.4	6	11.0	33.5	3	0	0	3.0	2	7.0	9.0	5	0	6	13	24.0	4	3	7.0	104.0
0301	3.0	1.5	1.5	6.0	5	4	0	9.0	4	0	2	4	10.0	4	0	7	4.5	10.0	5.7	2	0	33.2	0	3	0	3.0	2	9.0	11.0	5	5	3	10	23.0	5	3	8.0	103.2
0401	0	3.0	3.0	6.0	5	2	3	10.0	0	2	0	0	2.0	0	0	9	4.5	6.0	0	0	5.5	25.0	3	3	3	9.0	2	25.0	27.0	2	0	3	8	13.0	5	3	8.0	100.0
0402	3.0	1.5	3.0	7.5	2	4	4	10.0	4	2	2	4	12.0	4	0	9	12.0	10.0	7.0	4	11.0	57.0	3	3	3	9.0	2	18.0	20.0	2	5	6	11	24.0	4	5	9.0	148.5
0404	3.0	3.0	1.5	7.5	5	4	2	11.0	4	0	2	4	10.0	4	2.0	6	4.0	5.0	2.5	0	0	24.0	3	3	3	9.0	2	20.0	22.0	5	5	3	14	27.0	5	4	9.0	119.0
0405	1.5	1.5	1.5	4.5	2	4	0	6.0	4	2	2	4	12.0	4	2.0	9	6.0	3.6	5.6	0	0	30.2	3	2	2	7.0	2	17.0	19.0	5	5	3	9	22.0	4	3	7.0	107.7
X				5.75				6.75					5.94									30.25				3.81			12.97					18.31		8.19	93.39
S.D.				1.98				3.17					4.07									9.12				3.80			6.85					6.47		.81	25.14

APPENDIX H

STUDENT ATTITUDE SURVEY
(QUESTIONNAIRE)
DATA

Table 28

Record of Student Attitude (Questionnaire) Responses

A. COURSE CONTENT AND OBJECTIVES

1. Objectives taught in the first 20 lessons:

Obj. #:	1	2	3	4	5	6	7	8	9	10
Responses:	20	19	11	16	10	11	14	7	7	2

Obj. #:	11	12	13	14	15	16	17
Responses:	2	3	2	10	10	6	8

2. Objectives necessary to do HFE Test and Evaluation:

Obj. #:	1	2	3	4	5	6	7	8	9	10
Responses:	8	8	7	7	9	9	10	5	9	7

Obj. #:	11	12	13	14	15	16	17
Responses:	11	10	12	5	9	8	6

3. Objectives which would help you do your job:

Obj. #:	1	2	3	4	5	6	7	8	9	10
Responses:	10	12	11	9	10	9	12	6	9	8

Obj. #:	11	12	13	14	15	16	17
Responses:	8	7	13	9	9	13	6

Table 28 - Continued

B. COURSE DESIGN

	Student Responses: Most Positive 5	4	3	2	Most Negative 1	Total
1. Sequence of lesson topics	2	14	4	1	3	24
2. Concept development	1	13	5	2	3	24
3. Format	1	11	2	5	5	24
4. Remediation	1	6	9	3	4	23
5. Info provided before questions	1	11	9	2	1	24
6. Info provided after questions	2	5	14	1	2	24
7. Question quality	1	11	10	1	1	24
8. Answer choice quality	1	10	10	1	2	24

C. COURSE PRESENTATION

9. Course w/o on-site instructor	1	8	7	4	4	24
10. Freq. use of CCS	15	6	3	-	-	24
11. Terminology--defs. provided	6	9	7	2	-	24

Table 28 - Continued

D. STUDENT SUPPLEMENT

	Student Responses					
	Most Positive				Most Negative	
	5	4	3	2	1	Total
12. Effectiveness of course elements						
Tables	2	15	6	-	-	23
Charts	2	14	7	-	-	23
Graphs	2	13	8	-	-	23
Illustrations	2	15	6	-	-	23
Symbology	-	12	8	2	1	23
Legends	-	14	7	1	-	22
Terminology	-	15	6	-	2	23
Lesson outlines	3	10	8	1	1	23
Arrangement of tables & graphs	-	12	7	3	1	23
13. Usefulness of Student Supplement as a reference	-	6	10	7	1	24
14. Student Supplement (usefulness & self-explanatory)--figures & tables	-	8	13	3	-	24
15. Clarity of symbols and legends	4	11	7	1	1	24

Table 28 - Continued

E. RESOURCE DOCUMENTS

	Student Responses					
	Most Positive				Most Negative	
	5	4	3	2	1	Total
16. Course made reference documents easier/harder to use:						
1472C	2	8	7	2	-	19
1474B	2	7	5	2	-	16
HDBK 759	2	11	5	2	-	20
17. Use of ref documents in planning HFE T & E made easier/harder:						
1472C	-	10	6	3	-	19
1474B	-	8	6	3	-	17
HDBK 759	-	11	5	3	-	19

F. HUMAN FACTORS ATTITUDES

18. Is HFE T & E necessary:	12	10	1	1	-	24

G. MISCELLANEOUS

19. Story Line Effectiveness:	1	3	10	4	6	24

Table 28 - Continued

G. MISCELLANEOUS (cont'd)

	Student Responses (Never) Most Postive 5	4	3	2	(Always) Most Negative 1	Total
20. Factors Adversely affecting completion of lessons:						
Experience	10	5	5	3	-	23
Education	10	4	5	3	1	23
Time Available	1	1	9	9	3	23
Job Load	1	--	7	11	3	22
Course Length	6	6	5	4	2	23
Format	3	6	5	1	9	24
Terminology	8	2	9	5	-	24
Design	5	4	3	4	5	22
Temporary Additional Dury	6	3	8	5	2	24

H. COURSE DESIRABILITY

	Yes	No	Total
Students want to keep course materials.	10	14	24
Students want to keep Supplement only.	13	11	24

APPENDIX I

QUESTIONNAIRE DATA
FROM CURRICULUM DEVELOPMENT EXPERTS
ON TERMINAL LEARNING OBJECTIVES

Questionnaire Data From Curriculum Development Experts on Terminal Learning Objectives

1. An understanding of common terms used in human factors engineering.

Criteria	Number of Experts Responding			
	N	S	M	C
1	3			
2	3			
3	3			
4	3			
5	3			
6	3			

2. A familiarity with human factors references and an ability to use them.

Criteria	Number of Experts Responding			
	N	S	M	C
1	2	1		
2	1	2		
3	1	1	1	
4	3			
5	3			
6	3			

3. An awareness of potential sources of technical information on human factors topics.

Criteria	Number of Experts Responding			
	N	S	M	C
1	3			
2	3			
3	3			
4	3			
5	3			
6	3			

4. An understanding of the goals of human factors engineering in a materiel development program.

Criteria	Number of Experts Responding			
	N	S	M	C
1	3			
2	3			
3	3			
4	3			
5	3			
6	2	1		

5. An ability to integrate human factors principles in a DOD sponsored program.

Criteria	Number of Experts Responding			
	N	S	M	C
1	2	1		
2	1	2		
3	1	2		
4	3			
5	3			
6	2	1		

6. An ability to determine human performance requirements in a systems concept.

Criteria	Number of Experts Responding			
	N	S	M	C
1	2		1	
2	1	2		
3	1	2		
4	3			
5	3			
6	3			

N = Not at all S = To some degree M = Mostly C = Completely

Table 29 - Continued

7. An understanding of kinds of factors and forces which affect human performance and an ability to identify and measure them.

Criteria	Number of Experts Responding N	S	M	C
1	2	1		
2	1	2		
3	1	2		
4	3			
5	3			
6	3			

8. An awareness of the differences between field and laboratory measurement.

Criteria	Number of Experts Responding N	S	M	C
1	3			
2	2	1		
3	2	1		
4	3			
5	3			
6	2	1		

9. An awareness of what "expermental control" measures are necessary for any test involving human performance and the effects in their absence

Criteria	Number of Experts Responding N	S	M	C
1	3			
2	2	1		
3	2	1		
4	3			
5	3			
6	2	1		

10. An understanding of basic statistical techniques, such as analysis of variance.

Criteria	Number of Experts Responding N	S	M	C
1	3			
2	2		1	
3	2		1	
4	3			
5	3			
6	2	1		

11. An ability to calculate human performance reliability.

Criteria	Number of Experts Responding N	S	M	C
1	2			1
2	1	1		1
3	1	1		1
4	2		1	
5	3			
6	2	1		

12. An ability to formulate performance measures for the dependent variables of time and error.

Criteria	Number of Experts Responding N	S	M	C
1	2		1	
2	1	1	1	
3	1	1		1
4	2		1	
5	3			
6	2	1		

N = Not at all S = To some degree M = Mostly C = Completely

Table 29 - Continued

13. An ability to analyze human performance data within the context of "system effectiveness" and "system reliability".

Criteria	Number of Experts Responding N	S	M	C
1	2	1		
2	2		1	
3	2		1	
4	3			
5	3			
6	2	1		

14. An understanding of the major techniques used by human factors specialists during system synthesis, design and development.

Criteria	Number of Experts Responding N	S	M	C
1	3			
2	2	1		
3	2	1		
4	3			
5	3			
6	2	1		

15. A familiarity with task analysis.

Criteria	Number of Experts Responding N	S	M	C
1	3			
2	3			
3	2		1	
4	3			
5	3			
6	2	1		

16. An awareness of the relationship between human factors engineering and the engineering specialists of reliability, maintainability and safety

Criteria	Number of Experts Responding N	S	M	C
1	3			
2	2		1	
3	2		1	
4	3			
5	3			
6	2	1		

17. An ability to interpret and apply the standards and specifications of the human factors engineering community.

Criteria	Number of Experts Responding N	S	M	C
1	2	1		
2	1	2		
3	1	1	1	
4	2	1		
5	3			
6	2	1		

NOTE: One of the Curriculum Development Experts felt that none of the objectives met any of the criteria at all.

N = Not at all S = To some degree M = Mostly C = Completely

APPENDIX J

SAMPLE RECOMMENDATIONS ON COURSE LAYOUT

Figure 1

Module Cover Page Format

MODULE 1.0

HUMAN CAPABILITIES AND LIMITATIONS

FOR

HUMAN FACTORS ENGINEERING

Course Identification Number _____

Prepared by

Pacific Missile Test Center, Pt. Mugu, California

25 December 1983

Figure 2

Module Overview Format

MODULE OVERVIEW

MODULE 1.0

Human Factors Engineering

HUMAN CAPABILITIES AND LIMITATIONS

In this module .....

List of Lesson Topics Included in Module:

Lesson Topic 1 - Welcome to Human Factors Engineering

Average Time: _____

Lesson Topic 2 - Why Human Factors?

Average Time: _____

Lesson Topic 3 - Tragic Mistakes...and Positive Consequences.

Average Time: _____

.
.
.

Lesson Topic 20 - Review

Average Time: _____

Total Module Average Time: _____

(Insert any general instructions to students concerning the use of this Module Booklet and any of its supporting materials.)

Figure 3

Lesson Topic Cover Page Format

HUMAN FACTORS ENGINEERING

MODULE NUMBER 1.0

LESSON TOPIC 1.1

WELCOME TO HUMAN FACTORS ENGINEERING

25 December 1983

Figure 4

Lesson Topic Overview Format

MODULE 1.0

LESSON TOPIC 1.1

LESSON TOPIC OVERVIEW

LESSON TOPIC 1.1

WELCOME TO HUMAN FACTORS ENGINEERING

In this Lesson Topic ...

The Learning OBJECTIVES of this Lesson Topic are as follows:

1.

2.

3.

4.

(Statement to the student that he or she should review the "LIST OF STUDY RESOURCES" and read the Lesson Topic LEARNING OBJECTIVES before beginning the Lesson Topic.)

Figure 5

List of Study Resources Format

MODULE 1.0
LESSON TOPIC 1.1

LIST OF STUDY RESOURCES

WELCOME TO HUMAN FACTORS ENGINEERING

To learn the material in this LESSON TOPIC, you have the option of choosing, according to your experience and preferences, any or all of the following study resources.

Written Lesson Topic presentations in the Module Booklet:

1. Lesson Topic Summary
2. Programmed Instruction Form of Lesson Topic
3. Student Supplement containing supporting information, charts, graphs, etc.
4. Lesson Topic Progress Check
5. Narrative Form of Lesson Topic

Additional Materials

1. Student Response Sheets
   a. Diagrams, charts, graphs
   b. Programmed Instruction Response Sheets
   c. Answer Sheet for use with all tests
   d. Notetaking Sheets

Enrichment Materials

1. Additonal Resource Documents from the Student Packet
2. Additonal References from the Naval Supply System

You may use any or all resources listed above, including the Learning Course Sponsor, but all materials listed are not necessarily required to achieve Lesson Topic Objectives. The Progress Check may be taken at any time.

Figure 6

Lesson Topic Summary Format

MODULE 1.0
LESSON TOPIC 1.0

LESSON TOPIC SUMMARY

Welcome to Human Factors Engineering

(A condensation of the narrative form of the lesson topic is placed here).

Statement to the student:

"At this point, you may take the Lesson Topic Progress Check. If you answer all self-test items correctly, proceed to the next Lesson Topic. If you incorrectly answer only a few of the Progress Check Questions, the Correct Answer page will refer you to the appropriate pages, paragraphs, or frames so that you can restudy the parts of this Lesson Topic you are having difficulty with. If you feel that you have failed to understand all, or most, of the Lesson Topic, select and use another medium of instruction: Narrative or consultation with the Learning Course Sponsor, until you can answer all self-test items on the Progress Check correctly."

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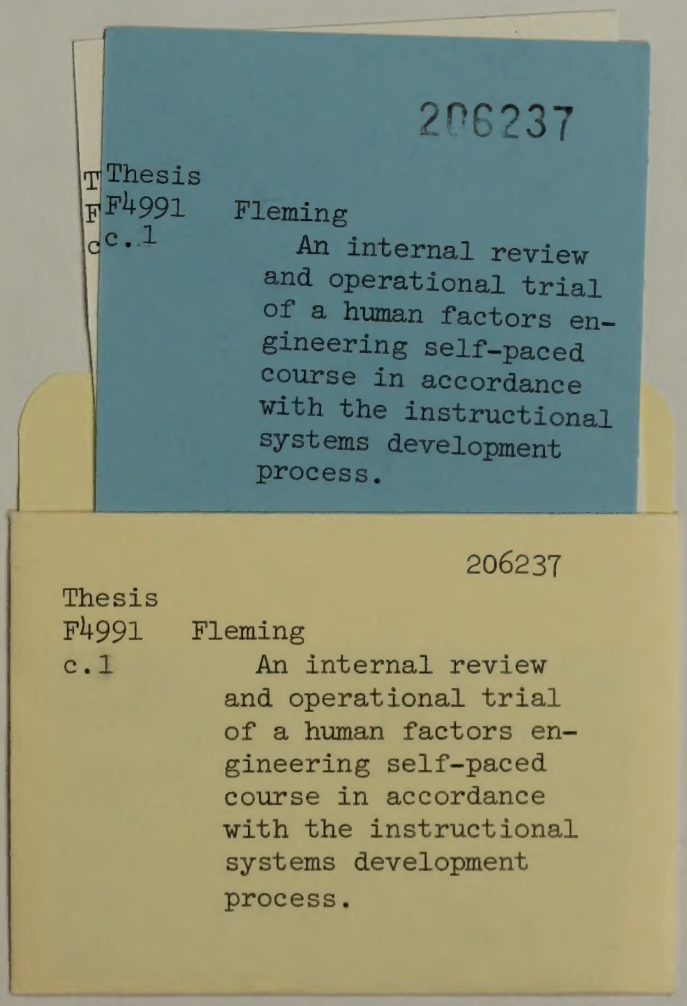

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